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TEXT BOOK

OF

VETERINARY MEDICINE

BY

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VOL. V.

SECOND EDITION

REVISED AND ENLARGED.

PARASITES, PARASITISMS, ETC.

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VETERINARY MEDICINE.

PARASITES AND PARASITISM.

Mutualism, Commensalism, Parasitism, Symbiosis, Rapacious enemies, venomous. Phytoparasites. Zoöparasites. Microbes: protozoa, bacteria. Ectoparasites, vegetable, animal. Entoparasites, vegetable, animal. Compulsory parasites. Facultative parasites. Temporary parasites. Intermittent, remittent, erratic. Monoxenous. Heteroxenous. Varying gravity of parasitisms. Conditions which increase gravity. Infection—bearing parasites.

When two animals or plants, or an animal and plant form an interdependent existence or association the relation is explained by one of three designations, *mutualism*, *commensalism*, or *parasitism*.

Mutualism is where two live together and are mutually dependent on each other, but the union is beneficial to both. Thus the acari that live in the feathers of birds and feed on the epidermic debris or dandruff are actually beneficial to their hosts and are strictly speaking not parasites.

Commensalism is where two live together, and the union is beneficial to one of the parties without proving injurious to the other. Myriads of infusoria live in the stomachs and intestines of ruminants but cause no appreciable injury, if indeed they are not beneficial in disintegrating the ingesta.

Parasitism differs from both in that one of the two draws its subsistence from the other to the appreciable injury of the latter.

The common term **symbiosis** (living together) may be applied to all three, but in *mutualism* the *symbiosis* is beneficial to both, while in *commensalism* the *symbiosis* is beneficial to one without harming the other, and in *parasitism* *symbiosis* is *antagonistic* and *injurious* to the host.

Another class which is closely allied to parasites is more purely **rapacious.** Besides the carnivorous vertebrates these embrace a number of smaller animals like leeches, mosquitoes, flies, bed bugs, etc.

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Finally **venomous** animals like bees, wasps, hornets, snakes, etc., may be conveniently named with the rapacious.

DIVISIONS OF PARASITES.

Parasites are naturally divided into the vegetable and animal.

Phytoparasites (phyton plant) or *plant parasites* are exemplified in the fungi of ringworm or thrush and the actinomyces of lumpy jaw.

Zoöparasites (zoön animal) or *animal parasites* are represented by the worms, acari, etc., etc.

The **Microbes,** whether appertaining to the animal kingdom (*protozoa*) or vegetable (*bacteria*), will be considered along with the infectious diseases to which they give rise.

Parasites are further divided according as they live *upon* or *within* the body of their host :—*ectoparasites* (*ek out*) and *entoparasites* (*entos within*). Each of these may be animal or vegetable, thus we have :

Ectoparasites { **Ectophytes, Dermatophytes** (derma skin)
Ectozoa, Epizoa (epi upon).

Entoparasites { **Entophytes** (entos within)
Entozoa.

Again parasites are divided according as they are *constantly* and *compulsorily* parasitic, or *occasionally* or *accidentally* parasitic; as they prey upon one species or genus of host or upon many; or as they prove parasitic only at one stage of their development. Thus we find :

Compulsory, Obligatory, Constant or **Stationary Parasites** which must live on the animal or vegetable host or perish. They are unfitted to pass their existence elsewhere. Of these we have examples in the psoric acari, lice, fleas, etc., of the skin, and many of the worms.

Occasional, Accidental, Facultative or **Temporary Parasites** are such as can live on a given genus or species of host, but which can also, if need be, fill out the round of their existence independently of such host. They have the *faculty* of living on this host if *opportunity* serves, but this is not necessary to their survival. Among these may be named leeches, trombidia, dermanyssus, actinomyces, trichophyton, etc.

Some **temporary parasites** pass only a certain stage of their existence in or on the host, and yet this parasitism is essential to

the preservation of the species. Among these are the tæniæ which spend their larval or cystic stage in one animal and their mature stage in another which preys upon the first. The trematodes in their larval stage infest a mollusc and as adults they live in ruminants and other mammals. The echinorhynchus as a larva infests the May beetle, and as the mature worm the pig which eats the beetle. These are compulsory parasites, but not permanent ones.

Intermittent Parasites embrace such as come to the host for nourishment and then leave it at once. The diptera furnish many such examples: mosquitoes, gnats, simulidæ, tabanidæ, hæmatobia, stomoxys, which either draw blood or live on the secretions.

The term **remittent** has been applied to parasites which breed away from their hosts and come upon them in companies often at given seasons. We have examples in lice, fleas, woodticks, and leeches.

Erratic Parasites are such as infest not one species or genus but two or many, the choice being made in the individual case by opportunity. Thus most predatory diptera, some acari and ticks, fleas, bed bugs and the parasitic fungi belong to this class.

Monoxenous Parasites (monos one, xenos host) are such as live only in one genus or species of host, and though the ovum may pass out with the excrement, it or the embryo must be taken in again in food or water by a host of the same genus in which it developed.

Heteroxenous Parasites (éteros different, xenos host) are such as pass different stages of their lives in different hosts usually belonging to different genera. Several of these have been named above under temporary parasites. Among other examples are: *trichina* that leaves the parent worm in the bowels, and encysts itself in the muscles, which must be eaten by another host in order to its arrival at maturity in intestines of the latter: also *linguatula* which spends its larval stage in the lymph glands of the sheep, and its mature existence in the nasal sinuses of the dog which devours the sheep.

PARASITISMS: THEIR RELATIVE GRAVITY.

In prognosticating the gravity of an attack, or an epizoötic of any one of the different species of parasites, one must take into

account the relative injury caused by the individual parasite, and the numbers by which the host is likely to be assailed. Some, like trichina, echinococous, tænia fimbriata, or uncinaria, are so deadly and so likely to undergo a constant increase in the same locality in future years that their presence can only be looked on as a growing menace to be abated at any cost or trouble. Some are less gravely injurious, or increase less rapidly, so that they are usually looked upon with little apprehension. There are besides the commensals, like the analgesinæ, or acari of the feathers of birds, which are with good reason looked on as comparatively harmless.

With the object of placing in relief the more prevalent and habitually dangerous of the parasites, those that have been found to be especially injurious or destructive have been printed in blackfaced letters so that they can be readily picked out in a hurried glance over the list. But too much importance must not be attached to this conventional distinction,—the mere expression of past experience,—since any injurious parasite will tend to increase to a deadly prevalence when present in a given territory, in which the numbers of its natural hosts are very great, and in which other conditions conduce to its preservation and increase. If it infests two different genera of hosts in its two successive stages of larva and mature parasite, the presence of both genera in large numbers is essential. If it must pass a given stage (embryo, larva) in water or in some invertebrate, then wet lands, marshes, pools, lakes or sluggish streams are a necessary condition. If salt is destructive to embryo or larva, as in the case of the trematodes then such waters must be fresh. If the larva, as in the case of tænia canina, lives in an invertebrate skin-parasite of the same host, then the existence and maintenance of the intestinal or other internal parasitism is dependent on the presence of the cutaneous parasitism. If the parasite, like echinorhynchus must pass through its early immature stage in the larva of an invertebrate like a maybug or cockchafer, then an outdoor life, where the pig can grub-up and devour the invertebrate larva, is the condition of becoming infested. Again, if the parasite, like trichina, is usually taken in by devouring the smaller rodents (rats, mice), or the food or water which they have contaminated, then the excess in pigpens of such vermin, which have become

contaminated by devouring the carcases, offal, scraps, of other infested animals, or the water or food contaminated by these, becomes the main condition of an outbreak. So with the hundreds of other conditions varying with the parasite, the host, and the environment, the rule is that these conditions must be changed before we can hope to get rid of the parasitic invasions. But so long as, and wherever, these favorable conditions exist we must be prepared to face an outbreak of parasitism, and this by reason of the local increase of parasites, which until now, and elsewhere, may have been considered as comparatively harmless. Thus it is that the existence and gravity of a parasitism often depends quite as much on the favorable conditions of the environment as on the presence of the parasite. But given a real parasite, with injurious qualities, the aggregation of a large number of the animals that form its normal host, and an environment especially favorable to its preservation and propagation and we must be prepared to meet with an extensive, dangerous and destructive outbreak. No previous, lengthened period of immunity, and no history of this parasite showing an apparent harmlessness, must be allowed to blind us to the probability of a dangerous increase of such parasites whenever the conditions become in every way favorable. As the potato-beetle can only live and multiply where potatoes are grown, so the parasite of the animal can only increase where there is an abundance of its hosts. And as with the host so with the conditions of the larval existence of the parasite. Both are essential in many cases, and when both are present they may cause outbreaks of which no preceding counterparts can be found.

For the same reason most parasitisms can be dealt with by changing the condition of the environment, and in this way cutting off the next generation of the parasitic organism. This is usually too much ignored, and treatment is too often confined to the mere exhibition of parasiticides, which, however effectual in preserving the individual animal, does little towards the much more philosophic resource of extirpating the parasite. This is the counterpart of the same faultily circumscribed view and action, which expends itself on measures of serum therapy and immunization in the case of contagious diseases and declines to grapple with the far more important and immensely more econo-

mic resort of extinguishing the infection itself and banishing it for all time from a country. To deal with parasites so as to cut off their sources of survival, and extirpate them from a locality, a fuller knowledge of their life history is demanded than for simple parasiticide medical treatment. The broader view and the more economic prevention must therefore be the prerogative of the scientist, and the fact that each parasite or group demands a different management, establishes a greater call for a profound study of the subject. Here as elsewhere knowledge is power, and should be recognized and appreciated as such.

PARASITES, ETC., AS INFECTION-BEARERS.

An incidental evil of parasitism and attacks of rapacious enemies, is found in the conveyance from host to host, or from victim to victim, of the germs of communicable diseases. Coming directly from an animal which is the bearer of a pathogenic bacterium, protozoön, cryptogam, or smaller animal parasite, and proceeding directly to a healthy subject, belonging to a genus susceptible to such pathogenic guest, it can hardly fail to propagate the disease in the second victim.

The fly or other insect feeds on the infecting material in the fæces, urine, nasal defluxion, ophthalmia-exudate, cutaneous secretion, pus of abscess or sore, venerial discharge, malignant tumor, and immediately betaking itself to food, drink, mucous membrane or open sores, lodges the infecting germs on the latter. Insects, that are *not biting nor blood sucking*, carry the infecting matter on their legs and palpi and also in their intestines so that it is left in the defecations (fly marks) on food and buildings; while *blood sucking* insects carry it as well on the mouth perforating apparatus (dart, hypostome etc.) and often in the blood imbibed. Infecting and putrid blood of abattoir and rendering works are similarly conveyed. The rôle of flies in conveying infection is today thoroughly appreciated by physicians and sanitarians and attention is being more and more directed to destroy these insects and remove their breeding places. It would be difficult to name an infectious disease that may not be largely conveyed by flies, and, in nearly all, the active propaga-

tion of the infection is greatly enhanced in the hot summer and autumn (fly-prevailing) weather. In winter, chicken cholera may often be restricted by a simple fence, whereas in summer it oversteps all boundaries that are not effective barriers to the flies. The same remark applies to anthrax, blackquarter, hog cholera, and a host of other contagious diseases. The trypanosomiasis, Surra, is almost exclusively conveyed by flies, and is therefore in the main a disease of the tropics where flies are constantly present. The plasmodia which cause the different forms of malaria, are chiefly transferred by the mosquito, *anopheles*. That which causes yellow fever is carried by another mosquito, *stegomyia*. The typhoid fever of man is so often carried by flies that it has been proposed to name the *common house fly*, the *typhoid fly*. This would be unfortunate in two ways: it would virtually imply that the familiar *musca domestica* was to be dreaded for typhoid only, whereas it is an active propagator of every infection to which this industrious little insect can gain access; and it would turn away attention from the many other channels through which typhoid fever is conveyed even in the absence of flies, and would further foster the thought that even in summer all other insects may safely be ignored in taking measures against the extension of that fever. The house fly is only one of many invertebrate bearers of this and other infections, and is only preëminently dangerous because of its rapid, and almost limitless reproduction, and because of its love of feculent matters on the one hand and food materials on the other.

Other diptera, the larvæ of which live on or in animals are capable of conveying infection with them into the tissues. To this class belong the *blow flies* (screw fly, cayor fly, the maggot fly of sheep, etc.), the *oestridæ*, the larvæ of which hibernate some in the stomach and intestinal tract of solipeds, others in the nose and nasal sinuses of sheep, goats, etc., and others in the muscular and subcutanous connective tissue of bovine animals. Infection can be and is conveyed by these larvæ.

The miscalled **sheep tick** (Melophagus ovina), which is really a bloodsucking, wingless fly, through its wide prevalence on long and middle wooled sheep, and the many skin perforations made by it, can constitute itself a source of great danger in connection with many contagious diseases.

Some flies are very impartial in their choice of victims and thus readily convey infection between different genera of mammals ; others confine their attacks to particular genera and thus work in a more restricted field. Those however that restrict their activities to definite genera are thereby in a sense favored as regards the conveyance of infection seeing that in the animal from which they obtain the virus they find the infection peculiar to that genus, and in going at once to another member of the same genus they are more likely to implant a germ of unimpaired potency in a specially susceptible subject.

Fleas do not suck blood yet by their vicious and constant biting they make many entrance-atria for the virus, and by reason of their great activity and unsurpassed saltatory powers they pass readily from one animal to another and too often with a sublime impartiality as to genus or species of their victims. In such successive attacks of different animals they cannot fail to carry the germs from the diseased to the healthy and are now incriminated as the main propagators of the *plague*. It is impossible to conceive that they are limited to that disease in the conveyance of infection. The rat flea of Russia avoids man and fails to propagate plague, whereas the fleas of man, cat, and dog do convey it. The West Indian fleas which burrow the head in the skin, and the Chigoe which buries its whole body in a cutaneous chamber where it lays its eggs and hatches its young, produce more local inflammation, weaken the power of tissue-resistence and invite infection still more strongly.

Lice, whether blood suckers or bird lice make cutaneous sores, for the infection to enter, and also carry infection from animal to animal. Though more sluggish than fleas, and though they confine their attacks to given genera and species which have a special attraction for them, yet they will get on unpalatable species, as well, and only find their mistake when they have bitten them.

The bugs proper, whether bed bugs, or those of the pigeon's or swallow's nest, are chargable with the same habits. Tuberculosis is transmitted to successive occupants of a bug-infested bed and, if tuberculosis, then other communicable diseases can be conveyed by these disgusting invertebrates.

Mites and **ticks** belong in the class of infection bearers. The large class of mites which are not *compulsory* parasites of mam-

mals, but *opportunists* rather, seizing on man or beast when occasion serves and biting or burrowing in the skin, cause great irritation and not only weaken the tissues in their resistance to bacteria, but even on occasion introduce these bacteria. To this class belong the *red or harvest mite*, the *tetranychus* of Argentina, and the *harpirhynchus* of pigeons, etc. Of the more purely parasitic are the *mites of the air sacks* and those of the *connective tissue* of chickens, the *burrowing mites* which cause the inveterate types of mange in each group of animals, the *nonburrowing mites* which cause the more common forms of mange and the foot-mange, those causing acariasis of the ear in dogs, cats, ferrets, rabbits and poultry, and the mites of the sebaceous follicles and Meibomian glands. To these should be further added the linguatula denticulata, the mature form of which is found in the nose and air passages of canine races, solipeds, cattle and sheep, and the larvæ in the lungs, liver and lymph glands of sheep, goat and other live herbivora especially.

The larger forms of Acarina known as *ticks* have been long incriminated as bearers of infection from animal to animal. Since 1868 American stockmen have noted that the victims of Texas fever were always infested with the Cattle ticks (Margaropus annulatus), but it was only since the discovery of the protozoön (piroplasma bigeminum, in the ticks as well as in the blood of the bovine victims, that the intermediary function of the tick as a bearer was clearly and indisputably demonstrated. This piroplasma is however transferred by other ticks in the absence of the annulatus, as in Australia and South America, and it would be presumptuous to say that still others may not take up the rôle under special conditions. The tropical and subtropical ticks, now known to convey the infecting protozoön, however, select bovine races as their main victims and in the absence of these ticks the disease would be rarely developed, would no longer spread as a scourge and there would be good prospect of its dying out. In the severe winters of the Northern States the annulatus perishes in the open air and thus the disease does not reappear in the following warm season. It should be added that in Europe the claim is made that the piroplasma bigeminum is carried from animal to animal by Ixodes ricinus, and I. hexagonus. In Northern Europe the microbian disease

louping ill is conveyed by Ixodes ricinus, I. marmorata, I, erinaceous and I. marginatus. But apart from one or two contagious diseases, the ticks generally which prey upon animals must share with all parasites and predatory invertebrates in the charge of conveying microbian diseases. The sanitary and preventive treatment of all such diseases therefore should always provide for the restriction and, where possible, the extinction of such parasitic and predatory invertebrates. This may imply the seclusion of given infected grounds from given kinds of stock until they shall have passed through a prescribed rotation of cultivated crops, the substitution, on non-arable lands, of one genus or species of animals which is repulsive to the tick for another that attracts it, the control of marketing of animals that have been on such infected lands, the exclusion from infected lands of all animals that harbor the invertebrate bearers in an earlier and larval form, the removal of all conditions, (wet soil, stagnant water, manure, organic rubbish, etc.) which would favor the breeding and increase of the invertebrate bearer, and no less the destruction or sanitation of all animals that act as hosts and preservers of the bearers of infection.

In the case of annelids, whether they infect the alimentary tract, or its associate glands, the lungs and air passages, the urinary apparatus, the blood and organs of circulation, the serous cavities, or solid organs, the same dangers attend and similar precautions are demanded. The embryo or mature worm is a convenient bearer of microbes into the system, and it is likely to do so when it migrates from the place of entrance into another organ or tissue, or again when it bites the surface it forms one or many adventitious openings through which the microbes find a ready entrance to the deeper parts. It is not to be forgotten that these parasitic annelides sometimes produce injurious toxins which, operating on the blood globules produce hæmolysis and resulting debility, and thereby enormously reduce the resisting power of the system to the increase of attacking microbes.

This baneful work of infection through worms becomes possible virtually in all cases in which this class of parasites are in evidence. It is least in case of worms that live only on the surface or in internal cavities, subsisting on the contents or secretions and incapable of biting the surface, or boring their way

into the tissues. Much more dangerous is the large class of blood sucking worms, which, like sclerostomata, whipworms, strongylina, œsophagastomata, uncinaria, etc., pierce the mucosa with teeth, or plunge the head through the soft tissues to reach and suck from the capillaries. No less redoubtable is that large class which as embryos or larvæ burrow into or through the mucosa and find a temporary home in sores, chambers, cysts, serous cavities, solid organs, and mucosæ other than that of the alimentary canal. As examples of these may be named the six-hooked embryos of the tapeworms, the trematodes of the spleen, lungs, muscles and blood, the trichinellæ, the ollulanus, the nematodes of the heart, blood, urinary system, skin, eye and other organs. Nor can we ignore those parasites, that, living as embryos in moist soils, waters etc., bore their way into the skin producing at first the dermatitis known as *ground-itch* and later, disease of those deeper organs in which the parasite finds a more permanent home. The uncinaria notoriously pertain to this class, but there is strong reason for suspicion that still other nematodes enter the system by a similar channel.

This modern, scientific point of view at once remands old doctrines and obsolete methods of simply vermifuge treatment to an inferior place. The insanitary and plague-propagating effects of parasitism appear in a new and far more important light, and we are failing in our duty toward microbian and other communicable plagues when we leave this larger factor of parasitism out of account. The much belauded and universally advertised worm medicine retains a measure of usefulness it is true in seeking to destroy parasites already present in a stricken animal system, but it becomes wofully inadequate when we fully realize the tremendous importance of parasites as an accessory factor in the propagation of other deadly plagues. In the microbian pestilence the pathogenic microbe is of course the one essential cause, and nothing should be allowed to blind us to this fact nor to the necessity for the final and absolute extinction of that germ and with it of the deadly plague for every place and for all future time, but neither must we forget that in our fight to the death against the microbe we cannot safely overlook the parasite which ranges itself on the side of the pathogenic microbian organism and so powerfully contributes to its perpetuation.

In this connection it may not be entirely inappropriate to quote the predatory animals as another class of infection bearers. Carnivorous animals, devouring the weakened victims of contagious disease and the bodies of the dead, of necessity bear away on their paws, claws, lips and teeth the infection—microbes, which they drop in new localities, even if they don't inoculate animals directly by their claws, teeth and bills. Those that, like the dog, hide in the ground the choice morsels received, lay up the infection for a future date to be carried farther when hunger leads them back to their caché. Among birds, eagles, hawks, but above all the carrion—crow, vulture and buzzard battening on dead and decomposing carcasses are especially dangerous in the way of diffusing infection. The value of the vulture family as scavengers of the woods and fields has led to the enactment of laws imposing a heavy penalty on any one that may kill them, but in the presence of a deadly contagion the certainty of the dissemination by these birds is a much greater peril than would come from putrefying carcasses in the woods. The infection of wounds by the septic bacteria of otherwise sound carcases, may prove serious enough for the infected individual, but there is no danger of its starting a spreading and deadly plague, such as would follow inoculation with bacillus anthracis, the Klebs-Löffler bacillus, the bacillus pestis or the germs of sheeppox or rinderpest. The protection of the buzzard springs from a very onesided view, and is based on a desire to avoid what is undoubtly the least of two great evils.

PHYTOPARASITES. PARASITIC PLANTS.

FUNGI.

Trichophyton Tonsurans (trix hair, phyton plant, tondere to shear.) The fungus of circinate ringworm.

T. Epilans (making bald). In circinate ringworm, horse and calf.

Achorion Schoenleini (achor scurf). The fungus of honeycomb ringworm.

A. Keratophagus (keras horn, phagein to eat). The fungus of "seedy toe," onichomycosis.

Lophophyton Gallinæ (lophe crest). The fungus of White-Comb.

Saccharomyces Albicans (saccharos sweet, albicans white). The fungus of thrush of sucklings.

S. Guttulatus (guttula a little drop). In intestines of ruminants.

Aspergillus Fumigatus (aspergere to sprinkle, smoky).

A. Candidus (candidus clear).

A. Glaucus (glaucos sea green).

A. Microsporus (micros small, spore).

A. Niger (niger black).

A. Nigrescens (growing black).

A. Replens (filling).

Aspergilli are fungi becoming parasitic on the skin, and the fumigatus especially on the air passages and alimentary canal of birds and mammals.

Gutturomyces Equi. Fungus in guttural pouch of horse.

Fusarium. F. Equinum.

Actinomyces (actinos ray).

A. Bovis. The parasite of actinomycosis in the ox.

A. Musculorum Suis.

Mucor Racemosus (mucor mold, racemosus in clusters). In recurring tumor of horse's shoulder.

Cryptogam of Bursatti.

ZOÖPARASITES. DERMATOZOA. ENTOZOA.

COCCIDIOSIS. PSOROSPERMOSIS. *Coccidium Oviforme C. Tenellum.*

PARASITIC INSECTS.

ORDER DIPTERA (Two-winged: sucking proboscis).

SUB-ORDER NEMATOCERA (nema thread, keras antenna).

FAMILY CULICIDÆ, (culex gnat), MOSQUITOES: Antennæ long, delicate, six segments, in males plumose, legs long, abdomen long and slender, perforating proboscis, blood suckers.

Culex Pipiens Common mosquito.

Anopheles. Malaria-bearing mosquito: black spots on wings.
Culex Equinus. Pest of horses and other animals.
Stegomyia. Yellow-fever mosquito.

FAMILY SIMULIIDÆ. BLACK FLIES. Antennæ with many short, thick segments, abdomen short and thick, wings and legs short, blood suckers. Worry animals to death.

SIMULIUM REPTANS. Common near Paris, and in woods in Europe.

S. CINEREUM (cines ashes), gray.

S. MACULATUM, (macula spot), spotted.

S. Molestum, ADIRONDACK BLACK FLY. Pestiferous.

S. Pecuarum (pecus cattle), BUFFALO GNAT. Kills stock.

S. Meridionale, TURKEY GNAT. Destructive to sitting birds.

S. INNOXIUM. Swamps in North America. Harmless.

S. Columbaschense. Destructive to stock at Kolumbacz, Hungary, &c.

SUB-ORDER BRACHYCERES (brachys short, keras antenna). Antenna in three segments, the third ringed, palpi two-jointed.

FAMILY ASILIDÆ, **Robber Flies** (asilus horse fly.)

Asilus Crabroniformis, HORNET ASILUS. Like wasp, yellow thorax and tail.

FAMILY TABANIDÆ, (tabanus horse or ox fly.) Broad flat body, head broader than long, blood suckers.

Tabanus Bovinus, OX BREEZE FLY. 27 mm. long. Pestiferous.

T. Atratus (ater black), MOURNING HORSE FLY.

T. Morio, BLACK BREEZE FLY. 18 mm.

T. Autumnales, AUTUMN BREEZE FLY. Dark gray, brown bands, yellow legs, black feet.

T. Bromius, NOISY BREEZE FLY. Bright gray, yellow spots on abdomen.

T. Rusticus, RUSTIC BREEZE FLY. Dark gray, yellowish hairs.

T. Fulvus, TAWNY BREEZE FLY. White spots on abdomen.

T. ALBIPES. WHITE FOOTED BREEZE FLY. 22 mm. Black, yellow hairs and legs.

T. ALBIFACIES. WHITE FACED BREEZE FLY. In North Africa.

Hæmatopota Pluvialis (hæma blood, poto. I drink) SMALL RAIN BREEZE FLY.

H. TENUICORNIS. (tenuis delicate, cornu, horn)

H. GRANDIS. Great blood-sucker. Clegg.

Chrysops Cœcutiens (chrysos gold, ops eye). BLINDING BREEZE FLY.

Nearly 50 North American species of chrysops have been described.

Pangonia Neo Caledonia, attacks cattle: carries germs of anthrax.

FAMILY SYRPHIDÆ (syrpho to trail). Rat tailed.

ERISTALIS TENAX, (eristes wrangler). DRONE FLY. Larva is *rat tailed*, seen in the horse manure.

HELOPHILUS PENDULINUS, (elos marsh, philo I love) Larva is *rat tailed* found in intestines of horse and man.

FAMILY MUSCIDÆ. Antenna with three articles, the third enlarged with dorsal bristle.

IST GROUP CALYPTERA. With covers of balancers. (calyptos covering).

Musca Domestica. HOUSE FLY.

M. Bovina. BOVINE FLY.

M. CORVINA. CROW FLY.

M. Vaccina. COW FLY.

M. VAGATORIA. VAGABOND FLY.

M. VITRIPENNIS. VITRIPENNE FLY. Glassy Wings.

M. Carnifex. EXECUTIONER FLY.

M. Stimulans. IMPORTUNATE FLY.

M. HORTORUM. (hortus garden). GARDEN FLY.

Stomoxys Calcitrans (stoma mouth, calcitro sting). STABLE FLY, of autumn.

Hæmatobia Serrata (hæma blood, bios life) HORN FLY. SAW FLY.

H. Stimulans. EXCITING HÆMATOBIA.

H. Ferox. FIERCE HÆMATOBIA.

H. Irritans. IRRITATING HÆMATOBIA.

Glossina Morsitans (glossus tongue, morsitans biting. "TSETSE FLY."

In Africa bears nagana infection to all domestic animals save the ass, goat, and elephant.

G. Palpalis. Bears germ of sleeping sickness.

Sarcophaga Carnaria. (sarcophagos flesh eating) CARNIVORUS S., Larva on dead meat, etc.

S. Magnifica. SPLENDID S. Larva on wounds.

CYNOMYIA MORTUORUM. (cynomyia dog-fly) Larva on dead flesh, etc.

CALLIPHORA VOMITORIA. (calliphora beautiful. Vomitorius causes vomiting) BLUE BOTTLE FLY. Larva on dead meat, etc.

Lucilia Macellaria. SCREW WORM. (lucidus clear sparkling, macellarius butcher stall). BUTCHER L. **Campsomyia Macellaria. L. Hominivorax.** Larva in wounds of men and animals.

Lucilia Cæsar. Larva on flesh and wounds, etc.

Achromyia Anthropophaga (ochros yellow). CAYOR FLY. Larva on wounds in man and beast in Senegal.

2ND GROUP ACALYPTERA without covers of balancers.

ANTHOMYIINÆ with three very small covers or hoods, many species.

ARICIA.

HYDROPHORIA (hudor water, pherein to bear).

HYDROTŒA.

Hydroteus Meteorica. About horses' heads during rain.

FAMILY HIPPOBOSCIDÆ (hippoboscus feeding on horse), PUPIPARA, LOUSE FLIES. Adults live like lice on skin; winged, wingless, or lose wings as mature. Antenna one jointed with terminal bristle. Ova hatched in parent's body.

Hippobosca Equina (boskein to feed). HORSE TICK. SPIDER FLY. Winged. Attacks horses, (cattle and dogs).

H. Canina. Attacks dog.

H. Taurina. Attacks cattle.

Melophagus Ovina. (Melon sheep, phagein to eat). SHEEP TICK. Wingless. Lives on coarse and middle wooled sheep.

Olfersia Americana. Winged. Lives on birds. LIPOPTERA. Young, winged, on birds; mature, wingless, on mammals.

FAMILY BRAULIDÆ. BEE LICE.

BRAULA CÆCA. On honey bee. Reproduction like Hippoboscidæ.

FAMILY ŒSTRIDÆ. BOT FLIES. Proboscis rudimentary; Palpi wanting or dwarfed. Larva hybernates in mammals.

Œstrus (Gastrophilus. Gastrus) Equi. Fly brownish yellow. Europe, Asia, Africa, N. America. Stomach (left sac): horse, ass, mule, solipeds.

Œ. (Gastrophilus, Gastrus) Hæmorrhoidalis. Fly blackish brown, yellow abdomen. Larva in pharynx, gullet, left sac of stomach, duodenum, rectum, solipeds.

Œ. (Gastrophilus, Gastrus) Pecorum. (pecus beast of burden). Fly, iron yellow. Larva in stomach and intestines; horse, solipeds.

Œ. (Gastrophilus Gastrus) Nasalis (Duodenalis, Salutaris). Fly black with brownish or golden thorax; larva in duodenum, posterior nares, pharynx, gullet and stomach, horse, goat; in brain and spinal cord, horse, ass, solipeds.

Œ. (Gastrophilus, Gastrus) Flavipes. Fly with yellow feet. Larva in stomach. Horse. Spain, Dalmatia, North Africa.

Œ. (Gastrophilus, Gastrus) Inermis. Larva unknown. Pupa in horse dung.

Œ. (GASTROPHILUS, GASTRUS) LATIVENTRIS. Broad bellied fly. Courland. Larva unknown.

Œ. (GASTROPHILUS, GASTRUS) NIGRICORNIS. Bessarabia. Black antennæ. Larva unknown.

Œ. (GASTROPHILUS, GASTRUS) RHINOCERONTIS. Africa. Larva in stomach; rhinocceros.

Œ. (Cephalemia) Ovis, Sheep Bot Fly. Fly small, gray, hairy. Larva in turbinated bones and nasal sinuses: sheep, goat. (Man and dog in Algeria).

Œ. VARIOLOSUS. South Africa. Larva unknown.

Œ. PURPUREUS. Central and Eastern Europe. Larva unknown.

Œ. Maculata, (spotted). Larva in nose, nasal sinuses and pharynx: buffalo and dromedary.

Œ. Trompe (Trumpet). Larva in pharynx: reindeer.

Hypoderma (Œstrus) Lineata, (hypo beneath, derma skin), **Ox Gad Fly.** America, Europe.

H. Suppleus. Probably same as lineata. Larva subcutem, near gullet, etc. Ox. Most frequent in America.

H. (Œstrus) Bovis, Ox Gad Fly. Larva subcutem, ox, (horse, ass). Europe.

H. (Œstrus) Silenus. (Larva subcutem, ass?)

H. (Œstrus) DIANA. Larva subcutem in stag and fallowdeer.

H. ACTŒON. Larva subcutem in stag. Europe.

H. Bonassi. Larva subcutem in American bison.

H. HETEROPTERA. Larva subcutem in Algerian ox.

H. Clarkii. Larva subcutem in South African ox?

H. (Œdemagena) TARANDI. Larva subcutem: reindeer.

Dermatobia (Cuterebra) Noxialis. Larva subcutem: ox, dog, man. Mexico, West Indies.

Dermatobia (Cuterebra) Cuniculi. Larva subcutem: rabbit, hare. America. The following are uncertain species.

CATTLE WORM. Larva subcutem: ox, man. Central Africa.

NUCHE or GUSANO in New Grenada, MACAW FLY in Cayenne, URA in Brazil, TORCEL in Costa Rica, MOYOQUIL WORMS in Mexico, attack ox and man and are probably DERMATOBIA NOXIALIS.

FAMILY **Pulicidæ. Fleas.** (pulex flea.)

SUB-FAMILY **Sarcopsyllina** (sarx flesh, psylla flea). Head large, thorax small.

GENUS SARCOPSYLLA.

Sarcopsylla Penetrans. CHIGOE. BURROWING FLEA. Ovigerous female, subcutem: man, pig, dog, cat, sheep, goat, ox, horse, ass, mule, birds. Tropical America and Africa.

S. Gallinarum. Burrowing Flea of Fowls. Africa, America.

GENUS RHINCHOPSYLLA. (Rhino nose). Hooked maxillæ recurved. R. PULEX. Found on parroquette and bat.

GENUS HELMINTHOPSYLLA. (Helminthos worm). Round head, large eyes, maxillæ triangular, straight.

H. VARIEGATA (ALAKURT). Attacks ox, horse, sheep and camel in Turkestan.

GENUS PULICINÆ. Head small, labia in four segments, eyes large, body narrowed.

Pulex Irritans. Flea of man.

P. **Serraticeps** (serrated or comblike head). Dogs and cats.

P. (**Ceralophyllus**) **Goniocephalus** (**Leporis**). Hares and rabbits.

P. **Avium.** Pigeons, chickens, swallows and other birds.

ORDER HEMIPTERA (hemi half, pteron wing).

SUB-ORDER. HETEROPTERA ('eteros different, pteron wing). BUGS PROPER.

Acanthia Columbarum (acanthos hook). BUG OF PIGEON NEST.

A. Hirundinis. BUG OF SWALLOW NEST.

A. (**Cimex**) **Lectularius.** BEDBUG.

REDUVIUS PERSONATUS. MASKED BUG. Burrows in wood; attacks man.

HARPACTOR CRUENTUS ('arpage rapine). South of France.

EULYES AMÆNA. Java, Borneo.

ARILUS SERRATUS. Brazil.

NEPA CINEREA. Water scorpion.

NOTONECTA GLAUCA. Water bug.

FAMILY PEDICULIDÆ (pediculus louse), LICE. Bloodsuckers. narrow elongated head: sucking tube.

GENUS HÆMATOPINUS. (hæma blood, pinein to drink).

H. Macrocephalus. Horse louse. Head very long and narrow.

H. Colorata. On ass, a variety of the last.

H. Eurysternus. (euros broad). Louse of ox.

H. Tenuirostris (tenuis delicate), H. VITULI. Louse of calf.

H. Stenopsis. Goat louse.

H. Tuberculatus. Buffalo louse.

H. Irritans (**Urius, Suis**). Louse of pig.

H. Piliferus. Louse of dog and ferret.
H. Bicolor. Head differs. Dog.
H. Ventricosus. Louse of rabbit.

FAMILY RICINUS (tick), MALLOPHAGUS, (mallos wool, phagein to eat). BIRD LICE. Head broad, biting mandibles, no sucking tube.

SUB-FAMILY PHILOPTERINA. Anterior part of the head separated from the posterior by a suture ; Antenna attached in a deep notch.

GENUS TRICHODECTES (trix hair). Antenna has three articles. Live on mammals only.

T. Pilosus, HAIRY T. Horse, ass and mule.
T. Parumpilosus (Pubescens), Pubescent T. Horse, ass and mule.
T. Ocellata (ocellus eye). Daw and ass. Variety.
T. Tarsata (tarsus heel). Horses in Java. Variety.
T. Sphaerocephalus (sphaer sphere). Sheep.
T. Scalaris (CLIMAX), SCALY T. Goat.
T. Scalaris var Major (limbatus). Angora goat.
T. Crassipes (crass broad, pes foot). Angora goat, kangaroo.
T. Latus (Broad). Dog. Host of cyst of tænia canina.
T. Subrostratus. Cat.

GENUS ORNITHOBIUS (ornithos bird, bios life). Body long, narrow, antenna with 5 articles, 1st long.

O. Bucephalus. Swan.

GENUS LIPIURUS. Body long, narrow ; antenna with five articles, first very short.

L. Baculus (baculum staff), ROD-SHAPED L. Pigeon.
L. Squalidus. L. of Duck.
L. Jejunus. L. of Goose. } probably varities.
L. Anseris. L. of Goose. }
L. Heterographus. L. of Chicken.
L. Variabilis. L. of Chicken and Pheasant.
L. Polytrapezius. L. of Turkey.
L. Numidæ. L. of Guinea fowl.

GENUS GONIODES. Body broad, flat ; antenna five articles, first short in male.

G. Minor. Pigeon.
G. Stylifer. Turkey.

G. Dissimilis. Chicken.
G. Colchicus. Pheasant.
G. Truncatus. Pheasant.
G. Numidianus. Guineafowl.
G. Falcicornis. Peafowl.
G. Parviceps. Peafowl.

GENUS GONIOCOTES. Gallinaceæ and Pigeons.

G. Gigas. Chickens.
G. Compar. Pigeons.
G. Rectangulatus. Peafowl, Guineafowl.
G. Chrysocephalus. Pheasant.
G. Hologaster. Chickens.

GENUS DECOPHORUS.

D. Icterodes. Ducks.
D. Adustus. Goose, variety of last.

SUB-FAMILY **Liotheinæ.** Antenna four articled; head very broad; tarsus with one claw.

GENUS GYROPUS.

G. Ovalis. Guineapig.
G. Gracilis. Guineapig.

GENUS TRINOTON.

T. Conspurcatum. Swan.
T. Continuum. Goose, probably a variety of last.
T. Luridum. Duck.
T. Lituratum (Squalidum). Goose.

GENUS COLPOCEPHALUM (colpos bay, pocket).

C. Longicaudum (cauda tail). Pigeon.

GENUS MENOPON.

Menopon Latum (Giganteum) Broad M. Pigeon.
M. Palidum. Pale M. Chicken.
M. Biseriatum. Chicken, Pheasant, Turkey.
M. Productum. Long M. Pheasant.
M. Phœostomum. Black Mouthed M. Peafowl.
M. Numidæ. M. of Guineafowl.
M. Obscurum. Duck.
M. Extraneum. Stranger M. Guineapig.

TRICHOPHYTÆ. (Trix hair, phyton plant.)

Trichophytæ like moulds, spores, mycelia, chaplets of spores: no sporangia. Grow on decomposing organic matter, and skin, especially what is hairy, or in birds bare or scaly. Favored by youth, free secretion, dandruff, damp, foul air, darkness, moulting, low condition and indoor life. On surface amenable to treatment; internally less so. Diagnosis: microscopic scraping or section, oil free by ether, cleared in solution of soda and carbolic acid, show fungus unchanged. Steep hairs longer. Cultures in alkaline or neutral bouillons. Sterilizing agents.

These closely resemble the moulds, having spores (conidia) mycelia (hyphæ, filaments), and chaplets of spores, but differ in the absence of true sporangia (spore cases).

The **Spore** consists of an amorphous envelope (epispore), enclosing a mass of central protoplasm. The **mycelium** (hypha, filament, tube), has also a homogenous wall enclosing an axis of protoplasm, which may be continuous, or broken up in segments, or it may be absent for short intervals. When this segmentation is regular at short intervals it gives rise to the formation of a chain of spores (sporiferous tubes, sporophores, receptacles). The spore is the seed, which may be preserved dry for an indefinite period, without change, but under favorable environment, it grows out into a filament, which may or may not be sporiferous. The propagation is through the spores. Ectospores grow, or bud, from the end of the filament, endospores within it.

Like their near allies, the mucorinæ (moulds), the *trichophytæ*, naturally grow on decomposing organic matter, but they also grow on the surface of living tissue under certain conditions of the latter. On the skin of man they show a predilection for hairy surfaces, whilst on the hairy animals they affect especially the head and neck, or, as in birds, even show a preference for parts (comb, wattles, legs), that are destitute of epidermic growths (feathers). It would appear as if a special condition of the system (youth), and the presence of excess of exudates and epithelial debris, and of a special chemical condition of these materials favored the growth of the cryptogam, which disappears from the surface when the conditions are altered. The freer secretions and desquamations in the young growing animal, the close air of winter stabling, the accumulation of stable dust and dandruff, the

damp and darkness of the building, and the susceptibility attendant on moulting have doubtless some effect in making the trichophytoses diseases of winter and spring especially, while the opposite conditions tend to their subsidence when turned out on spring pasture.

A fungus parasite usually localizes itself mainly on the surface, in the epidermis or epithelium where it can often be destroyed with facility by local applications. When on the other hand it colonizes the lining membrane of the air passages or alimentary canal, or when, as in actinomycosis or botriomycosis, it invades solid tissues, the treatment becomes more complex and less certain.

Diagnosis is based on the appearance presented to the naked eye, but above all on the presence of the pathogenic cryptogam. Scrapings or sections should be made of the most recent part of the growth (on the skin the deepest portion). Oily matters should be removed by steeping these once or twice in ether or absolute alcohol. The specimens are then placed in a mixture of equal parts of caustic potash or soda and water, with a few drops of carbolic acid, and examined under a magnifying power of 200 to 500 diameters. The epidermic products are thus rendered clear and translucent, while the unaffected spores and mycelia stand out in groups and filaments. When they have invaded the hairs the action of the alkali must be prolonged, but the effect is the same.

True to their habit of growth on dead organic matter these cryptogams may be further cultivated in artificial media, best at a temperature of 33°C. The various alkaline or neutral bouillons may be employed—peptonized bouillon, infusion of turnip or malt, or skimmed milk. These cultures are easily sterilized by solutions of iodine, carbolic acid, oil of turpentine, chloroform, corrosive sublimate, salicylic acid, or alcohol, offering suggestive methods of treatment for affected animals.

TINEA TONSURANS. CIRCINATE RINGWORM.

Common in the young—man and animal; transmissible from one to the other; early observations of this. *Trichophyton tonsurans* in deep layers of concretion, hair follicles, bulbs and stems; spores round, refrangent,

largest in horse and ox; filaments vary in size, protoplasm, membrane, segmentation, chains of spores; hairs break across, split, drop out; baldness. Trichophyton endothrix in human hair only. Trichophyton ectothrix outside the hair on animals and man; has smaller spores than endothrix. Probably varieties and interchangable. *Accessory causes:* Youth, confinement, close, dark, damp stables, moulting, abrasions, vermin, morbid skin exudates, crowding, common blankets, buildings, vehicles, posts, halter, harness, lack of grooming, contact of sick and healthy, dust. Susceptibility. *Symptoms:* Red papule, grows to round scaly spot, hairs erect, broken; split, all drop, those around bleached by chloroform, new spots form, progressive extension. *Cattle:* On head and neck mostly, thick on dark skins, one or two inches in diameter; under scurf, red, tender; itching slight; number attacked; attendant. *Horse:* On dorsal aspect mainly, rare on limbs; hair erect in tuft, scurfy base, then depilation, surface moist or dry, smooth, slaty; new hair causes dappling; *Dog:* Mostly on head, legs, feet; erect tuft; thin, bare scurfy spot; matting of adjacent hair by serum or blood; itching; white glistening skin, swelling. *Cat:* Mostly on face and paws (from mice); erect hairs in circle, depilation, bald spot, ½ to 2 inch. *Sheep:* On back, head or neck, as in cattle, or flattened tufts of wool with excess of scurf, shedding of wool, hangs in white tufts; itching. *Goat. Pig:* Scurfy spots one inch across, red, scaly; depilation; dry centre, moist margins. *Birds:* Congestion, scurf, depluming. *Trichophyton epilans:* More rapid growth, more destructive to hair. *Tonsurans* cultures show snowy tufts and little liquefaction of gelatine; *epilans* yellow pellicle and rapid liquefaction. Inoculation with skin products or cultures easy and successful, between genera. *Prognosis* good, except in neglected and cachectic. *Prevention:* Segregation of sick and well; oiling; use of separate articles in grooming, etc.; disinfection of brushes, combs, etc., by sublimate, iodine, carbolic acid; vitality of germ. *Treatment:* Depilation and burning; tar; carbolic acid; sublimate; creolin; naphthalin; salicylic acid; iodine; iodized phenol; oil solvents, clipping; shaving; hair extraction; cocaine; unguents; unguentum hydrargyri; balsam of Peru; copper sulphate; red precipitate, etc.

This affection is especially prevalent in children (3 per cent. in city common schools) and in the young domestic mammals. It is the direct result of the colonization of the skin by the cryptogam—trichophyton tonsurans. In Auvergne it was recognized as communicable from animal to man as early as 1831 (Grognier, 1838 (Lavergne, Carriere, Fehr), and 1852 (Bouley and Reynal). The cryptogam was discovered by Gruby in 1842 in the ringworm of man, by Bazin in 1853 in that of the horse, by Gerlach in that of the ox and dog in 1857-9, by Fenger in the cat in 1865, by Perroncito in the sheep in 1872, and by Siedamgrotzky in the pig in 1872.

Essential Cause: Trichophyton Tonsurans. This cryptogam is found in the deeper layers of the scurfy concretion on the affected part, in the hair follicles, bulbs and stems. It exists in two forms—*spores* or *conidia* and *mycelium* or filaments.

The **spores** are round or oval, 3μ to 4μ (extremes 2μ to 8μ) in diameter, with distinct outline and refrangent protoplasmic contents. In man and ox they are larger than in horse or dog.

The **filaments** are 4μ to 6μ thick (1μ to 5μ in dog), straight or flexuous, and rarely branching. They may vary in size in one host.

The protoplasmic matter, inside the homogenous outer membrane, may be continuous or broken up into segments, in certain cases taking on the form of chains of spores.

When invading the hair they extend longitudinally or transversely, and destroy the cohesion of the hair cells, so that it tends to break across, split up into smaller branching filaments (brush-like), or to be shed from the whole affected area. The resulting rounded and absolutely bald spots are very characteristic. Often the spores are so abundant as to hide the presence of the mycelium, and in other cases the filaments stand out prominently.

Sabourand describes two forms: (1) *T. Endothrix* growing not only on the skin but in the hair bulb and stem, which it renders brittle, so that it cannot be removed from its follicle: hence its inveteracy. *This is not found on animals, but only on man and especially on children.* (2) *T. Ectothrix* grows only or mainly outside the hair, though it may line its follicle and cover its stem. The hair in this case retains its toughness and is not easily broken, but is shed in one piece, and the way is left open for successful treatment. *This is found on cat, dog, horse, calf, chicken, rat and mouse*, and may be transferred to man (adults mainly). On the beard it produces patches in the form of a ring, with vesicles and pustules, and infiltration of the derma and hair bulb, surrounded by pus. The spores of *ectothrix* are smaller and rounder than those of *endothrix*. In Cincinnati Hospital, in one year, Ravogli found five cases in *children, all endothrix* and derived from other children, and nine cases in *adults, all ectothrix* and attributed to animals. Probably the two forms are varieties, determined by habit, and the transition takes place most readily by transference from animals to man.

Accessory Causes. These are the same as favor the cryptogams in general: Youth, confinement in close, damp, dark, winter quarters; moulting; abrasions by wounds, rubbing, vermin, etc.; accumulation of cutaneous secretions or exudates; crowding together of affected and healthy animals; the common or successive use of blankets, covers, buildings, cars, boats, rubbing posts, head ropes, halters, harness, etc., and the neglect of the free use of rubber, brush or currycomb. Above all the neglect to separate healthy stock from affected animals and men, and the places they have occupied. It is conveyed in sucking, in copulation or indeed by any direct contact, and the spores are readily carried in dry dust to fresh subjects. Judging from prevalence the order of susceptibility may be thus stated: man, ox, dog, horse, goat, cat, sheep and pig. Rabbits can be readily inoculated, and mice, rats and small rodents often convey the disease to the larger animals and man.

Symptoms and Lesions. Certain lesions are common to the different forms of the disease in the various animals On delicate skin, comparatively destitute of hair, as the lips, eyelids and inner side of the ear, the first indication may be a red papule, which gradually extends outward day by day, so as to form a more or less circular spot. The surface becomes scaly, the scales rising as a whitish concretion, and the hairs standing erect, splitting up into filaments, breaking across and finally dropping off so as to leave an absolutely bare centre. If wetted with chloroform a number of hairs near the bald spot become bleached, yellowish or gray, while the more distant and healthy hairs are unaffected. Other spots tend to appear in the near vicinity, where the spores have been lodged and thus a series of round, bare, scurfy spots are formed, which encrease from within outward, after the manner of fairy rings that grow mushrooms or toadstools on old pastures. The scurf may disappear from the centre while still extending at the periphery, as if the tissues had become immune, yet after a time, a new colonization may take place on such bare spot and the same method of extension may be repeated.

Cattle. In calves, yearlings and adult cattle the head and neck are most frequently attacked, the eyelids, ears, and in calves the lips being the favorite seats. It often shows in button-like, crusty elevations, the thickest on the darkest skins (Gerlach),

which may extend to one or two inches or more, shedding their hairs and finally the central scurf. If the scurf is rubbed off, the base is found to be swollen, red and angry, may bleed readily, and may exceptionally show small vesicles, or suppuration. Some itching may be present, but is not usually very marked. Several are usually affected in the same herd and ringworm may often be found in one or more of the attendants.

Horse. In solipeds the affection is especially seen on the upper parts of the body (shoulders, back, loins, croup, flanks), where the skin and hair are thicker, affording a better shelter for the spores, and where the spores are liable to be deposited by comb, brush, rubber or harness. It is rarely found on the lower parts of the limbs, yet Cousin found the shanks of a Guadeloupe mule entirely denuded of hair through ringworm. On a well-groomed horse the first indication may be the formation of an erect tuft of hairs upon a raised scurfy base, which rapidly extends with the accompaniment of depilation, and the exposure of scurfy or bare circular patches of the diameter of a quarter of a dollar or more. In many cases the hairs have merely broken across by the skin and can still be felt projecting from the bare surface. The surface is at first moist, but tends to become of a slaty gray, thickened, glabrous aspect. The circularity of the bare spots is characteristic, and even after new hair has started these give a dappled appearance because of the darker hue of the new and as yet unbleached hairs. When the new hair starts in the center, with the disease advancing all around so as to form a bare ring, it is still more suggestive. The itching is, as a rule, very slight, and rarely leads to irritating rubbing.

Dog. The dog is usually attacked on the head, eyelids, lips, legs and feet, but the spots may be found on any part of the body. The scurfy concretion and erection of a tuft of hair may be detected early, but usually the first symptom observed is the dropping of a tuft of hair, the accumulation of a white or grayish scurf and the exudation of serum and even of blood, which concretes in scabs, or mats the adjacent hairs. The spots may unite to form extensive and irregular patches, which prove more prurient than in the horse and much more inveterate. The depilated spots remain scurfy or clear and glistening for a length of time, and with marked discoloration and whiteness. Irritation and swelling, too, may last for a considerable time.

Cat. In the cat the face and paws especially suffer, the disease being often contracted from the mice caught, yet it may extend to any part of the body. It begins with a scurfy centre with hairs erect, which gradually extends, with falling of the hairs and the formation of a bare spot ½ to 1 inch in diameter.

Sheep. The disease prefers the back, head or neck, but may appear on any part of the body. On hairy parts the course is like as in cattle ; on the wooly there is manifest flattening of one or more tufts of wool, which become matted, and when separated show a dense scurfy accumulation around the roots. By and by the wool is shed, and may hang in white tufts among the healthy. The itching is much greater than in cattle and horses, yet incomparably less than in acariasis.

Goat. The affection follows the general course, but is comparatively less irritating or persistent.

Pig. Siedamgrotzky describes the scurfy patches as 2 to 5cm. in diameter, irregular in form, reddened and covered with scaly eruption. The bristles drop off and the centre of the patch becomes hard and dry, while the periphery remains slightly moist, red and scaly. Adjacent spots are liable to run together until a large part of the face or ears is involved.

Birds. Friedberger and Fröhner describe the disease in birds as causing marked hyperæmia of the skin and dropping of the feathers.

Trichophyton Epilans. Depilating Trichophyton. Megnin found in the horse a cryptogam which grew more freely in the stem, bulb and follicle of the hairs, and led to the evulsion of the hairs much more rapidly than with the trichophyton tonsurans in the horse. It grows also, as a rule, with greater rapidity, and in artificial cultures it forms at first a yellow pellicle and rapidly liquefies gelatine, whereas the tinea tonsurans forms abundant snow white tufts and liquefies gelatine very slowly (Duclaux). Megnin associates it with the trichophyton of cattle as a separate form. Even if the two have come originally from the same stock the maintenance from generation to generation of the distinctive pathogenic qualities, and the different behavior in cultivation media, seem to warrant their consideration as distinct pathological factors.

The **trichophyton tonsurans** of the horse produces in artificial

cultures very abundant snowy tufts and liquefies gelatine very tardily. The **trichophyton epilans** from the same animal produces at first only a thin slightly yellowish pellicle and liquefies gelatine with great rapidity (Duclaux). The difference, like that of the endothrix and ectothrix, is probably dependent on environment, transient, and the variety a temporary one.

Contagion from animal to animal has been so often observed and conducted experimentally that it must to-day be accepted as between different genera, and no less between artificial cultures *in vitro* and the living animal. Gerlach and Megnin transmitted the disease from ox to horse; Reynal and Nettleship from horse to calves; Epple from goat to ox; Gerlach and Fenger from ox to dog; Perroncito from ox to sheep; Siedamgrotzky from horse to dog, sheep and pig; Zurn from dog to cat; Fenger from cat to dog, and Lespian from dog to pig. Cases of transmission to man from the ox have been observed as early as 1820 by Ernst, and by thirty to forty observers since. Transmission from the horse to man was observed by Papa in 1848, and by a score of observers since. Transmission from dog to man has been noticed by Friedberger, Horand, Haas, Fröhner, St. Cyr and others. Contagion from the cat to man has been observed by Leidy, Fenger, Borch and others. It is interesting to notice that in this case the chain usually extended from affected mice and rats to the paws and face of the cat, and thence to the children who fondled the cat. Lespian records an epizootic in the Eastern Pyrenees in which the disease was introduced into one family by a dog, which first infected a pig, which in its turn infected the family in whose house it was kept.

Prognosis. The affection being a purely local one the prognosis is always good. In some cases it disappears spontaneously with the shedding of the winter coat and the turning on the succulent spring pasture. Especially does it give way under suitable treatment directed to the destruction of the cryptogam. On the other hand, the continuance of the disease by reason of neglect during winter, and under insufficient and dry feeding, is often associated with weak or cachetic condition, and when, in the very young especially, the lips become badly affected, prehension may become difficult or impossible, and marasmus may be the result.

Prevention. This is to be secured mainly by the separation of all affected animals, from other flocks and herds until the parasite has been destroyed. Or by the thorough inunction with oil or lard the spores may be prevented from rising in dust. Much more important is the avoidance of the use of combs, brushes, rubbers, blankets, harness, rubbing posts, cars, ships, etc., by the diseased and healthy in common. These articles may be boiled, steamed or soaked in a solution of mercuric chloride (1:500), iodine, carbolic acid, or other germicide. The stables, feeding troughs and other appliances should be thoroughly washed with a similar solution. Experiments have shown that the dry spores will grow freely after an exposure to air and light for eleven months, and the mere disuse of buildings cannot be trusted to, if of less duration than two years, (Megnin, Duclaux). Men handling the affected animals should be careful to avoid touching any hairy, and above all any abraded portion of their skin before the hands have been well disinfected.

Treatment. The purely local nature of the disease is a guarantee of the efficacy of topical treatment provided this can be brought into direct contact with the fungus without too much attendant irritation of the skin. Megnin has had success in young horses by scraping off the crust and adherent hairs, and burying them. The removal of the hairs removes an important field of parasitic growth in the hair bulb and follicle, and with cleanliness and above all with a parasiticide the case will do well. One part of tar and two parts of lard or sweet oil will often succeed. Carbolized glycerine (1:10) acts well. Mercuric chloride 1:300 of alcohol or proof spirit is excellent. Solutions of cresol, creolin, naphthalin, chloro-naphtholeum, lysol, salicylic acid, or iodine may be used. The preparations of iodine are among the best, and though iodine ointment will often succeed, yet such combinations as contain a solvent for the fatty and sebaceous matters that prevent the remedial agent from penetrating the affected hair follicles, are to be preferred. Thus tincture of iodine, or iodized phenol (tincture of iodine, carbolic acid and water, equal parts); or equal proportions of tincture of iodine, carbolic acid and chloral hydrate; or tincture of iodine carbolic acid and camphor, equal parts; or iodine 2 drs., oil of tar 6 drs.; carbolic acid in oil 1:10; or salicylic acid 1 part, proof spirit 2 to 4 parts; or salicylic acid 1 part, vaseline 2 parts, act well.

When the skin is unctuous some solvent of oil must be first applied, such as oil of turpentine (to be used cautiously in irritable horse), benzol, ether, chloroform, gasolene, or alcohol, or it may be thoroughly washed with green soap and this may be repeated daily, care being taken not to encrease the dermatitis.

Many cases will recover without clipping or depilation but if the hair stubs prove a barrier to treatment their influence should be reduced to a minimum. It is a good precaution to clip the hair all around the eruption. This will often reveal small centres of disease that would otherwise have escaped observation. It removes a means of shelter and preservation of the spores and secures the more effective penetration of the medicament. Shaving the part is good in some cases, while in others it proves a source of irritation. In very obstinate cases the individual extraction of the hairs may be demanded. This is especially desirable, when their follicles are the seat of excessive exudation or suppuration so that the hair is easily dislodged. Each hair in turn is seized by forceps with perfectly flat jaws and pulled out straight in the direction of its inclination, so as to avoid the tendency to break across. If the skin is too tender, it may be rendered less sensitive by the application of a solution of hydrochlorate of cocaine (4:100) or even by a solution of carbolic acid in glycerine and water.

If the diseased surface tends to dry up it is well to cover it with glycerine, vaseline and zinc ointment or other unctuous agent to prevent the ærial diffusion of the spores.

Among other agents in frequent use may be mentioned :—oil of cade and olive oil, equal parts: mercurial ointment: white or red precipitate (1:8 of lard); oleate of mercury; biniodide of mercury ointment ; creosote and glycerine ; oleate of copper ; alcoholic solution of copper sulphate ; tincture of balsam of Peru.

Care has to be exercised in the use of the mercurial preparations especially in the ox where absorption and licking of the agent are to be dreaded.

TINEA FAVOSA. FAVUS. HONEYCOMB RINGWORM.

Cap-shaped crusts. *Achorion-Schönleini*: Spores, round, oval, may be in chain form ; filaments, simple or branching waving, little protoplasm, abundance of spores (in receptacles), much homogeneous viscid matter full

of moving granules and rods. *Accessory Causes:* As in tinea tonsurans, debility. Affects rodents, cat, dog, man (possibly horse, cow and sheep). Cupped by growing around opening of follicle. *Symptoms: Cat:* On paws, lips, face, navel; sulphur yellow, cupped crust up to 4 mm., confluent; base of crust swollen, red, moist; mousy odor. *Dog:* Paws, lips, face, navel; crusts gray (yellow beneath), base inflamed. *Horse: Rabbit:* Paws, head, body; crusts up to one-half inch, spores very abundant. Young only suffered. *Prognosis* good, especially in spring, except in weak and debilitated. *Treatment:* Does best on delicate skin; remove scurf, depilate, apply sublimate, iodine, oxide of mercury, chrysarobin, sulphites, copper sulphate, salicylic acid, camphorated phenol, creosote, naphthalin, lysol, etc.

This is a contagious skin affection manifested by the formation of more or less circular and cup-shaped crusts, and caused by a vegetable parasite—*Achorion Schönleini.*

Essential Cause. Achorion Schönleini. This is shown in the crumbling, cup-shaped crust in the form of spores and mycelia after the manner of those of the *trichophyton* tonsurans, but with character so distinct that they are easily differentiated. The **spores** or conidia are round, or usually oval, and about 2μ in diameter (in man 3 to 7μ), according to Zurn they reach 8μ in birds and 12μ in the dog. They are often connected in short chains of three or four.

The **mycelial filaments** are usually 1μ to 3μ in diameter (in man 3μ to 4μ). Megnin has found them 4μ to 7μ in rabbits, and (Zurn 4μ to 8μ in dogs). They may be flexuous, simple or branching and appear empty, the protoplasm being in smaller amount than in the trichophyton. The spore tubes (sporophores, receptacles), differ in being more straight, larger, and in containing chains of true spores. The differences from the trichophyton tonsurans consist largely in the prevalence of oval spores, the comparative absence of protoplasm in the mycelia and their greater tendency to branching. The cupped aspect of the crust, and the presence of a homogeneous, agglutinating viscid material full of moving granules and rods between the more solid elements (spores and filaments) add to the clearness of the distinction. The microscopic examination for these elements is essentially the same as for the trichophyton.

Accessory Causes. These are the same as in circinate ringworm, being such as favor contact or the preservation and dif-

fusion of the spore. Debility favors as in the nine-year-old bitch of Trasbot, exhausted by gestation and nursing. Skin abrasions furnish excellent ground for colonization.

Animals Susceptible. It is common on mouse, rat, cat, dog, rabbit, guineapig, and, it is alleged by Neumann, the chicken and pigeon. Zurn, Megnin, W. Williams, Bassi, Friedberger and Fröhner describe favus in the horse; Williams and Girard in cattle, and Kowalewsky in the sheep, yet Neumann doubts the diagnosis. Children often acquire it from the cat, which, in its turn, received it from the rats and mice. Early youth is a strongly predisposing element, but age gives no guarantee against its ravages.

Development of Crust. According to Bazin and others the fungus is planted at the opening of the hair follicle and penetrates to the mucous layer between the epidermic layer and the true skin. As it multiplies and expands it rises all around, while the centre is held down by the connection of the epidermic cells with the surface of the hair. The cryptogam further invades the hair, directly (Unna) or by extending to its papilla and growing into its softer bulb (Kaposa. Balzer).

Symptoms. **Cat.** The disease being derived mostly from its prey (rats, mice), it attacks by preference the paws, lips, face, and, in the young, the umbilicus. The latter is infected by the lips and tongue of the mother. Once established at any point it, is liable to be speedily implanted on any other through scratching and licking. The crusts of a sulphur yellow when recent, or grayish when older, range in size from a mere point to a scaly cupshaped mass of 4 mm. in diameter, round or more or less indented at different points on the margin, and often becoming confluent so as to form extended patches. The central cupping, however, continues to mark out more or less perfectly the individual crusts. The cupping is less marked around the root of the claw, yet the irregular crust exhibits all the microscopic characters of the favus crust, (St. Cyr). On the affected parts the hairs have lost their luster, they stand erect and are easily detached. If the crust is carefully scraped off, the skin in the centre is depressed, smooth, moist, pale or red, while around the margin it is red and swollen, (St. Cyr). There is usually that heavy odor which in all animals attends on favus and which has been likened to the odor of mice, or cats urine.

Dog. In the dog there is the same tendency to invasion of the paws, the lips, face, and, in young puppies, the umbilicus. The crusts are more or less distinctly cupped, and though grayish white on the surface, they are sulphur yellow in the deeper layers, and covering a more or less congested derma. When a number have become confluent, the cupping becomes less distinct and the crusts may assume a slaty hue. Itching, which is mostly absent in cats, may be quite intense in the dog.

Horse. The essential appearance of the crust is like that seen in other animals. Friedberger and Fröhner speak of the crusts gathering in bands as wide as the finger.

Rabbit. On rabbits the paws and head are mostly affected, but it may extend to the body. The crusts vary in size from a pin's head to half an inch in diameter, and are flattened, or, in Megnin's cases, rounded and dry, the spores falling like those of a puff ball (lycoperdoid favus). Only young rabbits up to three months old were affected, those of four months and upward proving resistant.

Prognosis. In the larger and mature animals the disease tends to spontaneous recovery, especially when turned out to pasture in spring and at the time of moulting. Even when more inveterate it usually responds satisfactorily to treatment. On the young and especially on animals of small size (cats, rabbits, birds), it is liable to prove troublesome, extending to wide areas of the skin, interfering with sucking and inducing emaciation, debility and death.

Treatment. This is more satisfactory than in man, probably as claimed by Neumann, because of the relative delicacy of the skin and hairs of the domestic carnivora. At the root of the mane in the horse it may become very persistent. The treatment is like that for trichophyton. The scurf should be carefully scraped off without inducing bleeding, when the hair can be pulled out easily so much the better. Then some one of the parasiticides should be applied once or twice a day: Corrosive sublimate lotion, 2 to 10:100 (St. Cyr); tincture of iodine; ointment of red oxide of mercury, 1:8; ointment of ammoniacal oxychloride of mercury, 1:4; nitrate of mercury ointment diluted, 1 part to 3 of vaseline. As the mercurial preparations must be employed with caution in cattle, some of the following may be sub-

stituted: Carbolized oil (3 grs. to 1 oz.); soak for ten hours, then dress with ointment of chrysarobin in vaseline (1:16), or hyposulphite of soda (½ oz. to 1 pint), or freshly prepared sulphurous acid solution applied on surgeons' cotton and closely covered with gutta percha or other impermeable cloth. Or copper sulphate, oil of cade, salicylic acid, camphorated phenol, creosote, cresol, creolin, lysol or naphthalin or chloronaphtholeum or carbolized glycerine may be resorted to. Avoid excess of mercurials in cattle, and of phenol in dogs.

TINEA LOPHOPHYTON GALLINÆ. LOPHOPHYTOSIS. FAVUS OF FOWLS. WHITE-COMB.

Lophophyton gallinæ, more snowy culture on gelatine than achorion, and torn surface furnishes red fluid. Turns gelatine pink, and liquefies. Loses color in third culture. Chickens and rabbits suffer; rats and dogs immune. Potash solution shows filaments, containing little protoplasm, but spores sometimes red, forming chains and distending the filament. Form in rabbit. *Symptoms:* dirty, white, powdery, crusted comb and wattles, then head and body; feathers erect, or shed; follicles open; may be fever, thirst, somnolence, diarrhœa, emaciation, death. On legs has mousy odor. *Treatment:* Mercurials on comb, head, and neck; lysol, iodine, sulphites, carbolized iodine, etc., elsewhere.

This is described by Neumann as favus and due to the Achorion Schönleini. Megnin had, however, already sought to distinguish it, naming the parasite the Epidermophyton Gallinæ. When transferred from the chicken to the rabbit, or when the favus of man was implanted on the chicken, the lesions were indistinguishable, but Megnin, in 1890, showed that the cultures of the epidermophyton on gelatine formed a snow-white layer, which, when torn allowed the escape of a reddish fluid, that is not seen in the cultures of the achorion Schönleini. In 1899, cases of white-comb, investigated by Matruchot and Dassonville, showed that the alleged differentiation was inconstant, the coloration showing in the first or second cultures, but not in succeeding ones; it showed in cultures made on maltosed gelatine, and scarcely at all on peptonized gelatine. Upon gelatine the growth, at first white and downy, liquefies the gelatine and in a few days turns it pink. Upon peptonized and saccharated jelly there is a

white tomentous growth, with less liquefaction and tardier and less marked coloration, which may disappear altogether in the third generation. The cultures of the white-comb fungus are successfully and easily inoculated on chickens and rabbits, while rats and dogs, which are so susceptible to the favus of man, prove immune. As the term epidermophyton was already applied by Lang to another fungus, the name of *lophophyton* (lophe, crest) was adopted.

Lophophyton Gallinæ. The crusts from the affected comb are treated with caustic potash solution, 40 per cent., when the mycelium comes out clearly, especially if tinted pink. Many of these are mere filaments devoid of protoplasm, but others contain refrangent protoplasm, globular, with abrupt square ends, or arranged in a continuous chain in the middle or end of a filament and giving it a fusiform outline. These are called chlamydospores (cloaked spores). In the rabbit they resemble the trichophyton ectothrix of the circinate ringworm of the ox.

Symptoms. The prominent symptoms are the dirty white discoloration of the comb or wattles, with the presence on the surface of a dry, powdery crust, which may grow to a thickness of several millimetres. When produced experimentally by rubbing the comb with the powder from a diseased bird it develops in about fifteen days a white powdery patch in points of from a pin's head to about one-third inch in diameter. This gradually extends, adjacent centres become confluent, and in some weeks it may have invaded the whole comb, wattles, head and a great part of the body. Circumscribed areas of the ringworm may be discovered on the body as early as on the comb, in casual cases, if the feathers are parted so as to examine the skin. On the feathered parts of the body the feathers stand erect and are in part shed, leaving their round open follicles which have been mistaken for the honeycomb formation seen in *favus* in man. No such cup-shaped fungus growths are found, the cryptogam growing evenly on the surface and in the epidermis only. If neglected the malady extends, becoming generalized and causing fever, thirst, somnolence, digestive disorder, diarrhœa, marasmus and death. When it attacks the legs the lophophyton propagates beneath the scales, which it raises and loosens, and here, as elsewhere, it exhales a strong mousy odor.

Treatment is as in favus. The mercurial preparations may be applied to the comb, head and neck, while the less poisonous agents are to be preferred for parts that can be reached with the beak. The same precautions must be taken to destroy the fungus in the poultry houses and yards, but especially on the roosts, feeding troughs and nests.

TINEA DIFFUSA.

Small, dry, yellowish-gray scabs like hempseed, on back, shoulders, ribs, flank ; inveterate, itchy ; slight, refrangent spores blue in iodine, infected other horses and men ; resisted general treatment, but yielded to local.

Under this designation Goyau and Megnin described a dermomycosis of horses at St. Cyr, affecting especially the upper part of the neck, the back and the loins, and manifested by small, dry, scabby, yellowish incrustations about as large as a grain of hempseed, but thickly disseminated over the affected part of the skin. It extended downward in different cases on the shoulders, ribs, flanks and thighs. It will last for a year or more if neglected, and in the scanty eruptions is like the bald, chronic, tinea tonsurans of the scalp of man, as described by Bulkley. The affection is associated with itching, especially troublesome at night, and this leads to violent rubbing or biting and the escape and incrustation of blood and lymph so as to hide the microphyte. By turning back the hair so as to find a place which is not abraded in this way, the primary scab may be secured along with two or three entangled hairs, and under the microscope those show the presence of minute spores in clumps and chains, bearing a resemblance to those of the achorion Schönleini. The spores have a specially refrangent appearance. They are insoluble in acetic acid, ether, alcohol and oil of turpentine, and turn slightly blue under tincture of iodine. The failure to demonstrate mycelium or spore bearing filaments, is emphasized by Neumann who dismisses the observations as of no value. It should be recorded, however, that the affection, when neglected, and even when treated internally by all known antiseptic and derivative agents, persisted for years, whereas it yielded readily to a local application to the shaved surface, of an ointment of sulphate of

protoxide of mercury. Two similar cases came under my notice in Ithaca, in which both horses in a team suffered from an obstinate skin eruption with small incrustations entangling a few hairs each, diffuse irregular depilation, and considerable itching. The scabs and the extracted hair bulbs showed as in Megnin's cases, abundance of refrangent spores. The disease resisted general treatment but yielded to local applications. The owner of the team contracted the affection from scratching his shins after dressing the horses, and the veterinarian inoculated it on his eyebrow. In both cases the eruption proved inveterate, breaking out again and again, weeks after apparent recovery and when the treatment had been intermitted.

ONICHOMYCOSIS IN SOLIPEDS. SEEDY TOE.

Achorion Keratophagus in powdery degeneration of the horn tubes in the inner layer of the hoof wall ; the question of its pathogenesis.

Like Onichomycosis in man this has been found associated with a cryptogam which has been named Achorion Keratophagus (Ercolani). It is not improbably the achorion or trichophyton of the skin transferred to the horn, in which it grows mostly along the line of the horny tubes as filaments, and is associated with thickening, loss of cohesion and pulverulent degeneration of the horn. In solipeds the disorder shows as a soft powdery mass between the hoof wall and sole, and extending upward on the outer side of the keraphyllæ. Ercolani found filaments, spore bearing filaments and spores, but he failed to transmit them to two asses by sprinkling the powder on a blistered surface on the back. The experiment should be repeated on the raw keratogenous surface, or the abraded skin of young dogs and cats. The probability is that if the cryptogam only takes occasion to grow in the dead horn in connection with the destructive results of shoeing, laminitis and other injuries, it still adds to the already existing trouble by encroaching upon and breaking up the adjacent horn.

The successful *treatment* of seedy toe by paring down the walls of the cavity to the solid, healthy, tough horn, packing the cavity with tar and tow, and applying a carefully adjusted shoe giving

an even bearing for the hoof, and compression or support by a clip or otherwise, may be held to favor the idea of parasitism; yet the general indisposition to advance by contagion is opposed to the conclusion that the achorion is the main cause.

FUSARIUM EQUINUM. F. MONOLIFORME. SPINDLE-SPORE. *Fusus Spindle.*

Definition. A pleomorphous fungus found in a skin disease (Fusariasis) of horses, cattle and pigs. The same or closely allied forms are found on vegetables (cowpeas, watermelons, tobacco, cotton, ryegrass, maize, potatoes) and in the soil. Chickens feeding on the affected (mouldy) corn lost their feathers.

Historic Notes. The term *Fusarium* has been applied to a genus of fungi characterized by spindle shaped spores with sharp ends. Dietrich in Deutschlands Schwamme describes nine species, and of recent years the form has been largely found in vegetables and soils. In 1904 Sheldon, in Nebraska, described a *dry rot* on maize caused by a fusarium (*F. Monoliforme*), beaded like a necklace, and Peters found on the affected farms a skin disease of horses, cattle and hogs, in which the hair and, in horses, the hoofs were shed. Chickens lost their feathers. Feeding experiments with the mouldy corn produced the disease in hogs. Bitting in Indiana isolated a *fusarium* from mouldy corn which in feeding experiments on two horses led to refusal of the food after three days, and, when forced to eat it, caused on the fifth day, salivation, colic, and diarrhœa, and on the seventh day stupor and incoördination of movement, but no skin disease. Subcutaneous inoculation was ineffective. Hart found, in a particular shipment of hogs, to an abattoir, a skin disease, marked by lesions on the belly in the form of round patches, of the diameter of a dime to a quarter of a dollar, with congested periphery and a gray more or less scaly centre. Sections showed neither trichophyta nor fusarium, but the liquid from an incision produced *fusarium* in artificial culture. Others have found *fusarium* in the *wilt* of cowpeas, watermelons, tobacco and cotton and in moldy corn, ryegrass and other forage crops, as well as largely diffused in the soil.

In 1907 Melvin and Mohler published their observations on the fusarium as affecting horses in and around the Indian Reservation of Umatilla, Oregon. In 1901 Melvin found *Fusariasis* affecting 2500 of the 6000 horses on the Reservation in addition to sarcoptic acariasis in a limited number. Microscopic investigation showed the constant presence of the *Fusarium* even in those that were unaffected by the sarcoptes. The disease had spread into adjacent ranches, and threatened to extend over the entire district.

Symptoms. The fungus parasite appeared to concentrate its attacks on the hair follicles and bulbs, but was probably introduced as well through the abrasions and galleries hollowed out by the attacks of the acari, if not also carried on the surface or in the digestive system of the latter. Itching was intense, much more so in many cases than the lesions would indicate, "greater during the day than at night and in the warm than during cold weather." The animals rub against posts, fences and indeed every available object, bite themselves, and nibble each other, and sway the body as if scratching where the parts are rubbed with the fingers.

The first indication of the local eruption is the erection of the hair in isolated spots as in *ringworm*, passing the fingers over the surface they detect circumscribed elevations, and closer examination shows a scurfy elevation in which several hairs are involved. When this scurf is rubbed off there is left a red, moist, denuded surface. At first small, few and sparse, these spots encrease in number, diameter and thickness, and even coalesce to form large, dry, glabrous patches. The hair, at first brittle, broken and split up into brush like ends, finally disappears entirely. The lesions spread rapidly over the whole body except below the knees and hocks. The skin may be habitually drawn into folds by the action of the panniculus and is the seat of crusts, scabs, cracks and abrasions. "The crusts are gray at first, but turn darker as they grow older, and give off the usual odor of dead skin. The horses stand around the rubbing post all day indifferent about eating, and finally become anæmic and debilitated to such an extent that they die."

Morphology. Though *mycelium* may be found, the great mass of the fungus, present in scurf, scabs, hair follicles, seba-

ceous glands, and in dermal tissue, is in the form of the *spindle-shaped spore*, pointed at both ends, and curved in the shape of a crescent. The *early unicellular, unsegmented spore* (*microconidium*) is filled with a finely granular protoplasm without evidence of differentiation. This is crescentic and 6 to 15 μ. long, by 3 to 5 μ. broad. A *second, more advanced form* is the *macroconidium*, large, sickle-shaped, 3–5 septate, often constricted at the septa, and 25 μ. to 55 μ. long, and 2.5 to 4.5 μ. wide. This spore, which seems to grow on aerial mycelia, has the terminal two masses of protoplasm one half longer than the others. The *third method of sporulation* is by *chlamydospores*, oval, thin-walled, densely granular spores 8 to 15 μ. in diameter. These were found in small numbers in the older cultures only. Germination may take place in one or other of these spores, filaments growing from the apical or from the intervening cells, and developing microconidia or macroconidia indifferently from one or the other. In a rapidly growing culture there is formed a snowy white, or slightly colored, frost-like film, which in isolated colony assumes a circular form. The branching divergent, and crossing filaments forming this colony are individually divided by septa into oblong segments, the terminal one becoming enlarged, ovoid and crescentic and finally falling off as a microconidium. The next segment, now forming the terminal, then undergoes a like transformation and is dropped in the same way and thus sporulation rapidly advances. These spores may germinate in five hours in the hanging drop, the new mycelium being thrust out from any segment, terminal or median. In other cases the new filament, vegetates only, forming branching mycelia without spores for a time.

It grows very luxuriantly and is of a pure snowy whiteness, on potato broth, superficially and in its substance, and on bread steamed in distilled water. Next to these blood serum, and again peptonized bouillon form excellent nutritive media, both being liquified by the growing fusarium. Dunham's solution also proved favorable, and the cultures showed a yellowish and finally a chocolate tint on the deeper strata, though snowy white on the surface. Preparations of rice, whether alkaline or acid, proved poor culture media, showing for the first four days a marked increase in acidity, which is decreased or rendered

alkaline later. Rice cultures though white on the surface are liable to assume a pink hue in the deeper layers. Agar preparations proved the most unfavorable media. Alkalinity is conveniently ascertained by the phenolphthalein test.

Inoculation Experiments. In the hands of Mohler these were uniformly unsuccessful, even when he added the sarcoptes to produce infection atria, or to increase opsonic susceptibility. This is all the more remarkable because the disease spreads rapidly under given natural conditions. The optimistic conditions are however still unknown : it may be that a particular season or environment is wanted ; that the fusarium enters with greatest facility at the time of shedding the coat; that some particular condition of health and of the animal fluids is required; that some particular invertebrate or vegetable bearer conveys the requisite pathogenic stimulus in its own added products; that the optimistic moment for the growth of the individual spore has not yet been reached ; that an essential symbiosis with another microbe has failed, and the fusarium alone has been unable to accomplish the infection by itself. Examples of these and other essential accessory conditions have long been known and counted on in the case of other communicable diseases and even in connection with the higher vegetable organisms (aquatic and desert plants, those that demand lime, phosphorus, salt, etc., etc., those that refuse to grow in land long charged with products of the same vegetation, plants that need shade or sunshine etc.). Actinomyces were long inoculated without success, lactic acid dangerously increases the potency of anthrax or black-leg, just as the coincident infection by a weak culture of proteus vulgaris or micrococcus prodigiosus and the bacillus of malignant œdema has a most deadly effect. It is through ignoring such important accessory conditions that casual observations on communicable diseases, and even carefully conducted laboratory experiments, have often been the means of the acceptance of doctrines which are far from being generally correct, and which are productive of widespread harm.

Treatment. Well-directed treatment proved very effective. All diseased and worthless range horses were at once destroyed. Those having an intrinsic value were at once set apart from the sound animals and treated with the following : Light dynamo oil

1 gallon, sublime sulphur 1 pound. About 200 head were subjected to this treatment daily until all had been gone over, and the dressing was repeated, at intervals, on all that showed signs of persistence of the disease. The horses that were in constant use by the Indians were closely watched by those in charge, and on the slightest indication of the disease were at once dressed with coal tar sheep dips, or allied preparations (kerosene, coal oil and lard). A lime sulphur dip would especially recommend itself in such patients as had no wool to be injured.

ACTINOMYCOSIS. LUMPY-JAW.

Occurs casually in domestic herbivora and omnivora, and in men. Experimentally in dogs, cats, goats, rabbits, and Guinea-pigs. *History:* wens, osteo-sarcoma, etc., clubbed cells figured in 1845, 1848, 1868, 1863, 1871, and true nature demonstrated in 1876 by Bollinger. *Distribution:* In temperate zones especially, all altitudes, but mostly on damp lands, fens, polders, steppes, bottom lands, with barbed wire fences. Ratio in different centres. *Cause:* Actinomyces. Accessory causes: tonsillar follicles, raw gums, dentition, youth, sucking, dry fibrous winter fodder, buccal scratches, aphthous fever, thrush, stubble, carious teeth, gland ducts. Inoculations. Actinomyces: yellow granules like sand grains, filaments, cocci, terminal, divergent, (radiating) club-shaped cells forming tufts, first soft, later calcic, with degenerating central granular mass. Artificial cultures: pleomorphism. Virulence dependent on reaction in wound, and site of infection lesion. Varieties. Placed among moulds, cladothrix, steptothrix, oöspora, and bacteria by successive observers. Morbid anatomy: lymphoid, epithelial and giant cells, in cicatricial tissue, like sarcoma, bones swollen, chambered, filled with sarcoma-like product, suppuration, advance followed by contraction, phagocytosis. Metastasis in lymph cells. Usual advance is by contiguity. *Symptoms: Skin* has papillomata with microbe; *Tongue* becomes hard, indurated, necrosed, caseous, ulcerous; *Jaws* swollen, rounded, with points of softening, fistulæ, ulceration; *Palate, pituita, pharynx, abomasum, liver, spleen, kidneys, peritoneum, lungs, pleura, mamma, muscles.* Actinomyces of pig's muscle. Infection in man: grain, fodder, barley awns, straws chewed. Relation of microbe to gramineæ. Localization and lesions in man. *Diagnosis:* Presence of microbe, slow growth, invasion by contiguity, no preference for lymph system as in tubercle, cancer and glanders; by improvement under potassium iodide; from pyæmia and mycetoma. *Prevention:* drain rich damp soils, avoid fodders grown on them, especially in young, check the spread from affected animals, treat latter, boil carcases, disinfect stalls, sores, etc. *Treatment:* excision, pack

with iodized phenol, or blue stone, inject potassium iodide, curette the cavities, potassium iodide internally. Failures in cases of mixed (purulent) infections. Addition of antistreptococcic serum.

Actinomycosis is a chronic infective disease which occurs in cattle, swine, horses, sheep, elephants and men, and which is characterized by local inflammation and the formation of neoplasms containing the actinomyces. Experimentally the disease has been developed in dogs, cats, goats, rabbits and Guinea-pigs.

History and Geographical Distribution. What we now recognize as actinomycosis had long been known to stockmen and veterinarians as wens, cancer of the tongue, osteo-sarcoma, etc., but it was not until 1876 that its true pathology was demonstrated by Bollinger. When he had identified and accurately described the pathogenic organism, new observations of the affection were rapidly made not only in animals but also in man, and older records were brought to light which pointed early to this affection. The oldest of these dates back to 1845 when Langenbeck made drawings which showed the radiated arrangement of club-shaped cells found in pus derived from a diseased vertebra. In 1848 Lebert made equally unmistakable drawings of bodies found in the gelatinous pus from a thoracic abscess. In 1868 Rivolta described small cone-shaped bodies like those of the retina, which he found in pus from disease of the maxilla of an ox. In 1871 Robin described and figured similar bodies found by him in chronic abscesses. Perroncito in 1863 found these bodies in the diseased lower jaw of a cow. After Bollinger's demonstration, extended studies of the subject were made first by Johne, Ponfick, Israel, Wolff and others.

Actinomycosis is widely distributed in the temperate zones, and has not yet been recognized to any extent in the tropics where the closely allied disease **mycetoma** (Madura foot disease) is prevalent. While we find it at all altitudes, on the elevated plains of our western states as well as on the marshy river bottom or seacoast, yet its greatest prevalence is unmistakably in connection with *low, damp, rich bottom land.* In Great Britain we find it very common in the fens of Lincoln and Norfolk (Crookshank) and in river bottoms ; in Holland it is a disease of the polders (Jensen) ; in Germany it is frequent on the low, damp lands of Marienburg and Ebling (Preusse), and in Russia on the

rich Steppes stretching along the Volga (Mari) and Dnieper (Korsak). At some points in the Mississippi Valley it is very common and encreasingly so as the general use of barbed wire furnishes more numerous infection atria. Immenger has found it very prevalent in the Bavarian Palatinate and in Franconia, The abattoir statistics show for Berlin, in cattle, 1:5000, and in swine, 1:150000; for Augsburg, in cattle, 1:3000; for Bremen, in cattle, 1:4250, and in swine, 1:8000; for Stuttgart, in cattle, 1:1000; for Hanover, in cattle, 1:10000; for Moscow, in cattle, 1:3000, and for Warsaw, in cattle, 1:5000. In Moscow, Oskolkow estimates the ratio at 2.5 to 5.5 per cent. In Chicago, Salmon gives the ratio as 0.2 per cent. In LaVillette, France, Nocard gives 0.7 per cent.

Etiology. The cause of actinomycosis is the propagation in the tissues of the actinomyces. A variety of conditions may, however, contribute to this. As already stated it seems to be most prevalent on low, damp, rich soils where the pathogenic organism may find a favorable field for saprophytic growth. It has been supposed to grow especially on cereals and particularly barley, the beards of which favor its entrance into wounds of the skin and mucosæ. But the disease is found on western ranges where the cereals are never seen and must be traced to other forms of the gramineæ or to diverse vegetation and soil.

Whatever furnishes a favorable infection-atrium contributes to its prevalence. In swine the *follicles of the tonsils* have been found to enclose the parasite (Johne, Piana). The period of *teething* and the attendant laceration of the gums afford opportunity for colonizing, hence youth is a strongly predisposing condition. The relatively large size of the tonsils in early life, the softness and yielding character of the buccal mucosa, the congestion of the latter in connection with *sucking*, and the tendency to *aphthous stomatitis*, all contribute to an invasion. In older animals the winter season is the main period of invasion, the *dry, fibrous fodder* tending to scratch gums, checks and tongue and open the way for the parasite. Peletti has found it specially prevalent after an epizootic of *foot and mouth disease* on account of the wounds aud abrasions of the mucosa. In Eastern Europe, where it is a common disease of the lips, the infection is to be attributed to wounds sustained through the *rough herbage* of un-

cultivated lands. In old animals the *carious cavities* in diseased teeth form a favorite starting point for the parasite, and in all alike the *ducts of glands* may become the point of entry. It is alleged that in many districts cases have increased materially with the general use of *barbed wire fences* and the resulting skin wounds.

The disease is successfully transferred by *inoculation* as proved by Johne, Israel, Crookshank, Rotter and Ponfick. A fragment of granulation tissue inserted in the peritoneum of calves, and less certainly of dogs or rabbits, determines multiple tumors in the course of three months. Successful inoculations with artificial cultures have been made by Wolff, Israel and others. The resulting peritoneal neoplasms had strong fibrous envelopes and a soft pulpy interior containing the parasite. In one case secondary actinomycosis occurred in the liver, and in others artificial cultures on agar were made from the tumors. In Central Park Menagerie, N. Y., actinomycosis was found in the salivary gland of a grizzly bear, and in the liver of a prong-horn antelope, (Blair).

Actinomyces. The parasite is found in the form of yellowish or whitish granular bodies, quite visible to the naked eye, in the pus of the sores, and in the granulation tissue of the tumor. If the pus is shaken up in a test tube with salt and water these are easily seen like small grains of sand (0.1 to 0.5 mm.) sticking to the sides of the tube, and their appearance is almost pathognomonic. In the diseased tissues there is found a mass of fine filaments and cocci of various sizes and around this a variable number of branches ending in clusters or tufts of clubshaped cells in which the individual filaments terminate. These clusters or follicles when young are soft and easily broken up or sectioned for microscopic examination, but when old they become calcified, and intensely hard and resistant, and must be treated with weak acids before they can be prepared for the microscope. The sections or broken fragments of the granules show a beautiful concentric arrangement of club-shaped cells the thick ends forming the periphery and the inner ends terminating in the filaments. This gives the cluster the appearance of a daisy or other composite flower, though as Boström has shown, the arrangement is that of a hollow hemisphere, the filaments being attached to the

ends of the club-shaped cells on the concave side of the sphere. Occasionally a filament is to be seen with only two or three terminal club-shaped cells, and again a filament will grow out of the convex aspect of the hemispherical mass and develop a cluster of the characteristic cells beyond. In the older actinomyces clusters the center of the hemisphere contains the finely granular degenerated masses of the filaments.

In cattle a rosette of club cells is sometimes found without distinct filaments and in man the new and rapidly growing colonies may show the filaments mainly, with few or no clubs.

Under a strong light or a low power of the microscope the clustered ends of the clubs give the granule the appearance of a raspberry.

Under the microscope the decalcified granules are best examined after staining in Gram's solution or carmine, and by a $\frac{1}{12}$ oil immersion.

The actinomyces has been cultivated on artificial media by Israel, Boström, Crookshank and others. The colonies, in about twenty-eight days, at a temperature of 33° to 37° C., form bright rosy nodules surrounded by a network of fleecy white, and consisting of radiating filaments. In artificial cultures, clubs have not been found, so that Boström, Wolff and Israel look upon these as involution forms. Crookshank on the other hand considers the clubs to consist in a mucilaginous expansion of the sheath due to the extra stimulus of growing in the animal tissues with a rich and abundant nutrition. This pleomorphism or tendency to variation according to the culture medium, has been noticed by Gasperini in his extended investigation, and he found that a difference in its vigor of growth on given media, and even in its pathogenic properties, attached to variations in form. He found moreover that the virulence was largely affected by the intensity with which the inoculated tissue reacts and by the situation of the infection atrium. Among pathogenic forms Gasperini claims the following as being at least temporary varieties:— **Actinomyces bovis (hominis), A. Canis, A. Felis, A. Bovis Albi, A. Bovis Luteo, A. Roseus, A. Cuniculi,** and **A. Chromogenus** and **A. Gruberi** the last two being very destructive to Guinea-pigs. These are probably interchangeable according to the environment.

The organism is both ærobic and anærobic, and forms numerous spores by the continuous transverse division of the filaments. It was first ranked as a **mould**, later, by reason of its pseudo branching, as a **cladothrix** (Boström) or **streptothrix**. Sauvageau and Rabais however consider it as one of the higher **fungi** and create for the class the generic name of **Oöspora**. Crookshank assigns it to a place **intermediate between the higher fungi and bacteria.**

Pathological Anatomy. Around the actinomyces growth there is a great accumulation of lymphoid and epithelioid cells, with a few giant cells, and these in turn are surrounded by a greater or less abundance of firm, fibrous cicatricial tissue. Except for the presence of the actinomyces, the neoplasm bears a strong resemblance to sarcoma. When the fibrous formation is defective the mass is soft, friable and mainly cellular; when abundant it may attain the consistency of cartilage. In the bones of the face or jaw the neoplasm forms sarcomatous masses filling a series of excavations in the interior of the bone, which, greatly enlarged and distorted, covers these masses more or less perfectly with thin osseous walls. When invaded by pus microbes, as in cases of ulceration of the investing tissues, the neoplasm may be more or less surrounded or permeated by suppurating foci the products escaping through one or more fistulæ. Often the pus is formed in the centre of the tumor which still shows an extending surface of granulation tissue.

The disease advances by gradual invasion of all surrounding tissues, taking them into its substance after the manner of a carcinoma, and as it advances the neoplasm may undergo contraction behind into a simple cicatricial mass, so that there is a slow migration from place to place. In this process phagocytosis fills an important rôle, and if active enough will sometimes destroy the parasitic growth and determine a spontaneous recovery.

It should be noted that the spores and rod-like products of the microbe and even the club-shaped endings, sometimes enter the leucocytes (wandering lymph cells) and are carried to distant points, to start new colonies.

Advance by the lymphatics is, however, much less frequent than in the case of tuberculosis, syphilis, glanders, strangles, etc.,

and when lymph glands are involved it is usually by reason of their contiguity.

Symptoms in Animals. **Skin.** Cattle and horses especially suffer from one or more wart like nodules varying in size from a flax seed to a hazel nut, having a hard fibrous capsule and often a caseated or calcified centre. Ignatjew claims that 10 per cent. of the cattle from Southern Russia suffer from this.

Tongue. This, too, is most common in horses and cattle, the hard nodules forming on the surface or in the substance of the tongue which becomes densely indurated (hence the names "holzzunge," "scirrhus tongue"). The centres of the nodules may be necrosed and caseous, or there may be deep and irregular ulcerations, showing the actinomyces tufts or granules.

Jaws and Face. The most common seat of the disease in animals is in the jaw bone, especially the lower, starting from the alveolæ, or in the soft tissues of the face starting from abrasions or gland openings ("lumpy-jaw"). The jaw may show a simple rounded exostosis or the whole ramus may be swollen to a thickness of three inches and upward, with, as the disease advances, soft areas, or ulcers as the morbid process extends to the soft tissues or skin. The implication of the soft tissues leads to extraordinary swelling, induration and distortion, the head suggesting that of a hippopotamus. In the ulcers, or incisions the yellow actinomyces tufts are easily found.

Other seats. Similar nodules and thickening may be found on the palate, the nasal mucosa, the pharynx, the fourth stomach, the liver, spleen, kidneys or peritoneum, the lungs and pleuræ, the mammæ, and the muscular system adjoining the great splanchnic cavities.

The disease is usually slow in its progress, though at times when the germs are disseminated by the vascular system, it may become acute. Acute cases, however, with rapidly multiplying centres, are usually complicated by purulent infection.

Actinomyces Musculorum suis. Duncker found in the muscles of swine a parasitic growth resembling the actinomyces of the ox, but differing in some important particulars. Under a magnifying power of 40 to 50 diameters this appears as a cluster of roundish sharply defined cells. Under 300 diameters there

appear numerous micrococci with filaments enlarged at their free extremity. The surrounding muscle is discolored, softened, infiltrated with liquid, and repulsive. Hertwig who considered it as a distinct species found that infection was usually received in summer and autumn. Pfeiffer believed it to be a protozoan infection.

Actinomyces Infection in Man. The human being is exposed to nearly all of the causes which prove factors for infection in herbivora. The disease prevails largely in the same districts, and tends to start from wounds, or from sores of the gums in connection with dentition or carious teeth. It has also been frequently observed in persons working in the country among grain or fodder, or in cities in connection with grain. It has been plausibly charged to the habit of chewing grain or straw, or of picking the teeth with the latter. Still further barley awns, and glumes, and pieces of straw have been found in such cases in the hollows of the decayed teeth, in the follicles of the tonsils, and even in the actinomycotic fistulæ at a distance from the external opening. Soltman found in an actinomycotic fistula beneath the scapula a barley awn which was believed to have entered at the pharynx and advanced with the progress of the actinomycosis to the point where it was found. Ducer describes a case of maxillary actinomycosis in a women who had learned to clean her teeth with grain. Buzzi found in an actinomycosis of the neck a straw which had manifestly advanced from the point of infection in a decayed tooth. Ruge found organisms resembling actinomyces in four out of twenty-five tonsils examined, but similar objects are occasionally found in decayed teeth and their true nature is still uncertain. Hummel found one case with a piece of oat chaff in contact with the diseased mass, having evidently penetrated through the buccal mucous membrane. These are in keeping with Jensen's epizoötic in pigs said to have been caused by feeding on rye grown in the polders reclaimed from the sea in Zeeland, with Johne's discovery of actinomyces on rye imbedded in the follicles of pig's tonsils, and of Piana's case of lingual actinomycosis in the cow caused by a barley awn. Still more striking is the experiment of Korsak who inserted many wheat beards under the skin of the neck and shoulder of a yearling calf, and later found them covered with actinomyces. This was in Poltava

where the grains are especially liable to be attacked by this parasite. Elsewhere Bodamer found the parasite abundantly on grain, Jensen on rye, Brazzola on the hordeum murinum, and Johne and Piana on the glumes of wheat.

Direct infection from actinomycotic animals has been doubted, and even denied, yet in view of the many cases of successful inoculation it cannot be considered as impossible. It must be allowed that persons are usually about equally exposed to infection from the diseased animals and from the original sources of infection which acted on the animals themselves. It must also be admitted that of the many exposed to actinomyces from either vegetable or animal source but a very small proportion contract the affection. Casewell's experience of 17 cattle affected in a herd of 80 on a farm near Peoria, Ills., is altogether exceptional. Usually but one or two are found in a herd where the disease has existed for a length of time.

A certain amount of circumstantial evidence, however, supports the theory of its transmission from one animal victim to another. Oschner cites the cases of two farmers who contracted the disease after treating diseased cattle, and a *lumpy-jaw* horse. Barnard, O'Neil, Bergman and Munch quote cases of men suffering after long attendance on diseased cattle, and Baracz quotes a case of apparent transmission from man to man.

In view of the occurrence of actinomycosis in connection with the intestines. it must be admitted as a possible result of eating the infested food, vegetable or animal, yet direct experiments by feeding such food to animals have not proved successful. Man is largely protected by the cooking of his food.

In man as in animals a very large proportion of cases originate from the implanting of the parasite in a wound, so that it must be looked upon as, in the main, of traumatic origin.

Localization of Actinomycosis in Man. Judging from recorded cases actinomycosis is by far the most common in or near the upper part of the alimentary canal, and next in the chest, abdomen and skin. Among a number of cases, 78 were in the head, neck or œsophagus, 32 in the viscera and walls of the chest, 30 in the abdomen, 10 in the skin and 2 in the brain. In the **head** the following parts suffered: the teeth, alveolæ, jawbone, cheek, intermaxillary space, tongue, lachrymal sac and

throat. Cases affecting the **neck** would extend to the **shoulder.** In the **chest** primary formations have been found in the bronchia, œsophagus and mammæ, and secondary in the mediastinum, lungs, intercostal spaces and pleuræ. In the **abdomen**, the **intestine, liver, peritoneum, bladder, womb, ovaries,** and **abdominal walls** have been invaded by the parasite.

Diagnosis. This must depend on the recognition of the actinomyces in the morbid product. With open sores this is not difficult. In their absence the soft swellings may be aspirated to secure a specimen, or the hard bony one may be incised and scraped. The following should be ground for suspicion: the slow progress of the disease, the comparative absence of pain or tenderness, the tendency to invade all adjacent tissues indiscriminately neither selecting nor rejecting any particular organ, the indisposition to invade the adjacent lymph glands, more than other parts, the tendency when near the surface to form ulcerous sores or fistulæ leading to a more or less firm granulomatous tissue, the prior connection of the patient with ground infested with actinomyces, or the products of such land.

From **tubercle**, external forms may be distinguished by the comparative immunity of lymphatic glands, and internal ones by the absence of reaction to tuberculin.

From **Cancer** it differs in showing no predilection for the glands, in many cases by the comparative immunity of the skin, by the less violent character of the pain, and by the tendency often shown to advance while improvement goes on in the previous seat of the disease.

From **glanders** it is distinguished by the absence of any special disposition to attack the lymph glands and nasal mucosa, and by the absence of any reaction under mallein, and of agglutination of the blood-serum in contact with a culture of bacillus mallei.

From these and **other neoplasms** it is distinguished by its tending to improvement under a course of potassium iodide. In this it agrees with the gummata and fibroid growths of **syphilis** in man, but in that disease there is usually a history of heredity or infection, the presence of the characteristic chancre, mucous patch, siphiloderm, or sore throat, the contour of the syphilitic teeth or some other unequivocal symptoms.

From **pyæmia** it is to be distinguished by the persistence of the firm granulomatous product, the scanty production of pus around it, and presence in the pus of the yellow antinomyces tufts.

Hewlett and Canthack have sought to identify **mycetoma** (Madura foot disease) with actinomycosis, but there are some stricking differences. Mycetoma is largely a tropical or subtropical disease, affecting hand or foot, and avoiding other parts of the body—notably the jaw—which are so susceptible to actinomycosis. Actinomycosis is largely a disease of temperate latitudes, affecting the parts about the mouth, head and neck and internal organs, and rarely the hands or feet. The last attacks animals as well as men and in the same organs, while mycetoma is described in man only. The parasites of the two diseases are undoubtedly closely allied, but in view of their clinical characters it seems premature to pronounce them identical.

Prophylaxis. Considering the special prevalence of actinomycosis on damp, rich soils, the drainage of such soils offers a means of restriction of the disease. The fodders and vegetation raised on such soils should be withheld from animals with faulty teeth or those in process of dentition. To prevent undue encrease of the germ actinomycotic animals should be promptly treated, and in case of failure, slaughtered and safely disposed of. Animals the subjects of actinomycosis should not be used for human food unless the carcases have been subjected to a boiling temperature. The stalls of such animals may be disinfected by a saturated solution of cupric sulphate. In actinomycotic districts cleanliness and disinfection of sores and the hygiene of the teeth and gums should be carefully attended to.

Treatment. In localized actinomycosis removal by the knife, followed by disinfection with a solution of cupric sulphate or with iodized phenol, is very successful. In inoperable cases injections, into the diseased mass, of potassium iodide solution (1:100) may give equally good results. Rydygier repeated these injections at intervals of three to seven days for six weeks with successful results. Where ulceration has already taken place the subjacent granulomatous tumor should be as far as possible removed with a curette and the cavity packed with gauze or absorbent cotton charged with iodized phenol or Lugol's solution. Cavities in the

diseased bones may be scraped out in the same way, and loose teeth that are hopelessly useless are better removed. In 1843 Relph, an English veterinarian, claimed excellent results from the use of potassium iodide internally and locally.

In 1885 Professor Thomassen of the Utrecht Veterinary School employed in animals large doses of potassium iodide given by the stomach. One gramme (16 grains) for every 100 pounds of the subject's live weight is given daily for four or five days, when it should be withheld for two days, the animal being meanwhile given laxative medicine and diet. On the third day, when the watering of the eyes and other signs of iodism have subsided somewhat, a second course of four or five days is started, and in the same manner a third, fourth, fifth, sixth and seventh. Under this treatment over 70 per cent. of all affected animals recover.

The same agent has now been extensively used in the human being, the dose being according to size and weight up to 4 grammes (60 grains) daily. As in cattle, it proves especially valuable in internal and inoperable cases and even when the more prompt surgical measures can be taken this should never be omitted. No matter what unsuspected actinomycosis tumors may be present in varied parts of the body the iodide will reach them through the circulation and establish its beneficent work. It should be noted that a one per cent. solution of potassium iodide is not incompatible with the growth of actinomyces in vitro so that we look upon it not as a germicide alone, but as an agent which lowers the vitality of the germ and subjects it more absolutely to the destructive action of the protective serums and phagocytes.

In some instances the iodide treatment fails and this may in certain cases be attributed to a **complex infection** with pyogenic and other microbes. In one case which discharged pus freely containing both actinomyces and streptococcus Ducor had excellent results from a combination of potassium iodide and antistreptococcic serum.

GRANULATION SUMMER SORES WITH FUNGI. GRANULOMA FUNGOIDES. "BURSATTI." GRANULAR DERMATITIS. "LEECHES."

Bursatti with filaria irritans: with fungus, mycelium, spores, clubcells. Prefers bottom lands. ***Symptoms:*** **Lesion. Skin nodule, spongy, grayish yellow, granulations, calcic, detached, nodule-kunkur, leucocytes, fungus.** ***Treatment:*** **Infection by proximity rare; curetting, iodoform, iodine, carbolic, salicylic acid or sulphurous acid, bluestone, silver nitrate, cautery, potash, arsenic, cold douching, cold stable, tonics, potassium iodide, aristol.**

A granular dermatitis prevails in horses, during the hot rainy season, in India and Continental Europe and has been associated with the **filaria irritans**. In our Southern States, to a less extent, summer sores, showing similar characters, are met with in the same parts of the same animal year after year, but the filaria has not been discovered. Theobald Smith and P. A. Fish in independent observations found the **mycelia** and **spores** of a **fungus** permeating the granulation tissue of Florida specimens, but did not attempt the propagation of the disease by their culture. F. Smith and Steele had previously, in India, found a **brown mould fungus** in the tissue, and the former inoculated two horses and ten men with portions of the diseased tissue, but the results were negative except in the case of one man, who on the third day cauterized the wound and put a stop to the tingling and inflammatory action. Hart also failed to convey the affection from horse to horse. Bitting in Florida found the sores common on the lips and assumed that they were affected through rubbing and gnawing the sores elsewhere. In the absence of any direct proof of experimental inoculation, it must remain uncertain, whether the fungus is the essential cause of the disease or only a saprophyte which has incidentally grown on the raw unhealthy surface. Due importance should be attached to the facts that F. Smith, Steel, Druin and Renan, T. Smith and Fish found the cryptogam in all cases examined, that it was present not only on the surface, but throughout the substance also of the granulation tissue, that the disease prevails especially in given districts and particularly where the land is low and damp, and though it may become dormant in winter, it resumes its activity with the hot

weather of the succeeding year. While it may be carried by a diseased animal into high and dry localities, it does not show the tendency to extend in these as in the hot and damp low-lying ones. Finally improvement is shown under potassium iodide (Bitting). On the other hand many cases of so-called "bursatti" in India and Europe are associated with filaria irritans in the sores (Ercolain, Lemmer, Rivalia, Railliet, Laulanie, Baruchello, and Gunn) showing that at least two distinct conditions are known by the same name. Both forms attack horses and cattle, while other domestic animals appear to be exempt.

Distribution. In America it is especially prevalent in Florida where it is known as **leeches**, bearing reference to supposed leech bites, and indicating a relation to ponds, lakes, rivers and swamps in which leeches are found. Cases occur over the whole Atlantic slope and as far north as St. Paul, Minneapolis and New York. An occasional case is presented at the college clinic at Ithaca. As in Asia and Europe the affection follows the bottom lands of rivers, low, damp prairies, swamps, lakes and ponds. Cases seen on higher, drier lands are usually isolated, and at times imported from an infected district.

Symptoms. **Lesions.** In the more temperate regions the lesions are usually confined to the skin, yet this is not constant, and even at Ithaca we have seen the morbid process extend downward and inward, implicating the lateral cartilage so that a portion had to be excised. In damp tropical regions the lesions are much more extensive. Writing of Florida, J. H. Neal says it begins "as a grain of shot lodged beneath the skin. In eight or ten days the skin sloughs off centrally over this hard spot, leaving a bloody, bruised-like surface, exuding serum and blood, no pus. This rapidly grows in size until in a few weeks there is a raw surface from four inches to one foot square. An examination will show usually a mass of yellow, gritty growth, coral-like in shape, embedded in a mass of bruised bloody tissue, dark in color and the edges roughened, elevated above the skin and the skin decaying at the outside of the ulcer. The invaded tissues decay slowly and apparently without pain. I have seen hoofs cut off, the abdomen opened, the eyes eaten out, the teeth destroyed, etc."

As seen at Ithaca the fungous growth has appeared mainly on the limbs and trunk in spots varying from one-half inch to three inches in diameter, the soft spongy, grayish yellow mass rising above the level of the skin, rarely gritty, but soft and friable, easily scraped down to the level of the skin, and leaving a dark red bloody surface. When thus scraped off it grows rapidly to its former level or beyond, and though it may heal up during a cool period and above all in winter, yet it starts into renewed growth on the occurrence of hot summer weather.

In Florida specimens Dr. Fish found the well developed *nodule* (*kunkur*) more or less completely detached from the surrounding tissues. In the early stages it was soft and easily cut; later hard and gritty. Around the central portion was a zone of *leucocytes* (*polynuclear cells* predominating), a number of which contained spores. The nodule itself appeared to be composed of a dense network of *mycelium*, intermingled with disintegrating leucocytes and spherical bodies, probably *spores*. Many filaments ended in *club-shaped enlargements*, but these were not regularly pointed outward in tufts as in actinomyces. The calcification seemed to be mainly resident in the mycelial network. The solution of the animal tissues in a 10 per cent. cold solution of caustic potash for twelve hours rendered the fungous growth very evident.

Treatment. Accepting the disease as due exclusively to the local propagation of the cryptogam, one is unable to explain its spontaneous recovery on the advent of cold weather and its recurrence in the same seat with the onset of the hot damp weather of the succeeding season. Equally difficult is it to explain why in the more temperate regions like New York the disease will persist for years in one horse in a stable and respect the second horse of the same team, though dressed daily with the same brush and rubber, and pestered by the same flies that suck the liquids from the kunkurs. Manifestly, as in many cases of favus and ringworm, the one animal acquires a constitutional susceptibility to which the other is a stranger. It may be also that the spores hybernate in the system, to wake to new life the following summer. A purely local treatment may therefore be inefficient, yet such treatment of the skin, where the diseased process is so active, cannot be looked on as superfluous nor irrational.

In mild cases at Ithaca the scraping out of the nodule and the daily application of iodoform has secured a speedy healing. In

more advanced and inveterate cases the frequent douching with cold water from a hose or watering pan and the application of tincture of iodine have hastened healing.

In India the most varied opinions have been advanced. "Max" alleges that no bursatti sore will resist treatment if protected from the flies. Steel would prevent infection by covering all sores by antiseptic dressings, especially carbolic acid, and the infected sores should be dressed with carbolic, salicylic or sulphurous acid. Others have sought to slough out the diseased mass by the use of white arsenic in powder, or by cauterization with the actual cautery, caustic potash, silver nitrate, blue stone and other agents. All have found that the most important accessory to such local treatment was the advent of cold weather.

As a constitutional treatment, Western advocated tonics. Fayer, and later Bitting, claim a large measure of success from the administration of iodide of potassium until the system is thoroughly saturated. In other hands and during the monsoons the iodine treatment has been fruitless.

If the recurrence of the disease year after year in the same horse, in non-bursatti districts, is due to the hibernation of the spores in leucocytes, this would be a strong argument for the thorough destruction of the bursatti nodule by caustic, iodine and otherwise, at the earliest possible stage, before time has been allowed for much or any spore formation.

THRUSH OF THE MOUTH IN SUCKLINGS. MUGUET.

Saccharomyces Albicans. See Vol. II. p. 36.

SACCHAROMYCES GUTTULATUS IN THE RABBIT.

Saccharomyces Guttulatus is found in the intestinal mucus of cattle, sheep, swine and rabbits, without proving appreciably pathogenic. In the gall ducts of the rabbit however it has been found by Nasse and Remak to form masses like tubercles which interfere with the functions of the liver.

The cryptogam appears in the form of ovoid, dark, brown cells, each having from two to four clear transparent droplets from

which the name has been derived. They are arranged in pairs or short chains or in clumps. They do not appear to form any irritating or poisonous product, and produce mechanical trouble only.

ASPERGILLOSIS OF THE AIR PASSAGES IN BIRDS AND MAMMALS. PNEUMOMYCOSES.

History: Cause: Aspergillus, mother cells, branching transparent filaments, downy layer, vertical filaments, tufts or heads, spores or conidia. Grows on dead organic matter, but also on living surfaces. *Varieties:* Aspergillus—smoky, black, sea-green, translucent. *Accessory Causes:* Youth, delicacy, close buildings, cramming, darkness, damp. *Symptoms: Birds:* Wheezy, croupy expiration, catarrh, dyspnœa, moping, somnolence, debility, sunken head, wing, tail, eyelids, ruffled feathers, inappetence, thirst, hyperthermia, diarrhœa, emaciation, death in one to eight weeks. *Lesions:* On ærial mucosa back of nose tubercle-like masses or greenish patches, showing a mycelial surface; pseudo-tubercle in liver, diaphragm, peritoneum, intestine; contains many leucocytes and spores. *Pathology:* Inhaled spore grows on mucosa causing congestion, positive chemiotaxis, lymphoid and giant cells, fibroid organization. Intravenously, pseudo-tubercle in liver and lungs; intratracheally, death in 10 to 20 days. No strong toxin. Weak tissues most susceptible. *Solipeds: acute: chronic:* Fever, pulmonary consolidation, wheezing, nephritis, emaciation, death in 3 days to 3 months. *Lesions:* Hæmorrhagic foci with aspergillus, in lungs, kidneys and intestinal mucosa; or pea-like nodules with necrotic, caseated centre and mycelium. *Cattle and Sheep:* Feeble, hacking cough, oppressed, wheezing breathing, nasal discharge with mycelium; or like tuberculosis without response to tuberculin. *Lesions:* Miliary nodules, or like hazel nut or larger, central mass with mycelium, peripheral exudate with less, hæmorrhagic foci, ulcers on mucosa, blocked alveoli and bronchioles. *Dog:* Sarcomatous kidney, lung, spleen, womb, with mycelium. *Prevention:* Correct catarrhs, feed no aspergillus fodder, or boil it, or sprinkle with lime-water or sulphites; air, light, drain buildings, scald or disinfect, exclude affected animals, tame and wild, discard *cramming*. Raise new flock from eggs, on sound soil. *Treatment:* Fungicide inhalations (SO_2) and injections.

The first notice of mycosis of the lungs was by Meyer and Emert in 1815 in a jay, and since that date it has been often seen in wild birds (flamingo, eider duck, sea gull, stork, plover, parrot, bullfinch, raven, owl and falcon); and in domesticated (chicken, pheasant, pigeon, goose, duck, swan and ostrich).

More recently it has been seen in mammals—cattle, sheep, horse, dog and man.

Essential Cause. **Aspergillus** (aspergere to sprinkle) is a group of fungi of the order *Ascomycetes* (askos a bladder-bag) so named because the spores are formed by partial division in the interior of tubular mother cells. The spores are set free by the destruction of these spore bearing tubes. They form a dense felted **mass of branching, transparent filaments** (**thallum**), above which is a looser downy **layer** (**ærial mycelium**). From this last grow vertical filaments differing from the others in lacking internal septa, and bearing at their summits a number of branches (**sterigmata**), each of which at its free end forms a head (**capitulum**) of radiating globular spores (**conidia**).

The **Aspergilli** usually grow on dead organic matter. Their assumption of a parasitic existence on animals places them among the facultative parasites. Four species have been found to assume this parasitic rôle, one of which, the **Aspergillus Fumigatus,** is especially common and injurious.

Aspergillus Fumigatus (smoky). In this species the sterigmata do not branch, but each terminates in its own conidian head. The sterigmata are at first bright yellow or blue, from which they fade to a brown or dark gray smoky hue. The conidia are colorless and spherical.

Asp. Nigrescens (blackening). This resembles the fumigatus in color and general aspect, and the sterigmata individually divide into three to eight branches, each bearing a brown or brownish violet conidium.

Asp. Glaucus (sea green). In this species the filaments are partitioned at long intervals, the sterigmata are greenish-blue, yellow or brown, and the round or oval conidia grayish green.

Asp. Candidus (transparent). In this species the sterigmata are colorless and transparent, the capitulum is cut off short, and the conidia colorless or in masses snowy white.

Accessory Causes. Generali has found the more highly bred and delicate birds to contract this disease the most readily. This is in part to be attributed to the fact that such birds are too often kept in confined houses and yards to prevent contamination by crossing with inferior breeds, and in these the spores become concentrated and mingle with their food and water, as well as

with the air they breathe. A dry season favors its transfer in the dust. In establishments in which the birds are subjected to forced feeding (cramming) by means of a tube, this latter becomes a ready means of transfer from bird to bird. In a number of cases the attendant who fed the birds, by forcing the food from his own mouth through the tube into the stomach of the fowl has contracted the malady in this way. Damp, dark, close and unclean buildings favor the propagation and preservation of these as of other fungi and must be reckoned among the causes.

Symptoms in Birds. The breathing becomes, hurried, wheezing or croupy, and loudest in expiration. A catarrh sets in with spores and filaments in the expectorations. The dyspnœa becomes more and more intense and suffocation is threatened. The bird mopes alone, is drowsy, weak and usually resting on its sternum. When driven a few yards its legs fail and it drops on its breast. The head sinks between the wings, the eyes close, the feathers ruffle, and wings and tail drop. Appetite may be impaired or lost, but thirst is intense. The temperature rises above the normal, and diarrhœa and emaciation set in and advance rapidly. When the fungus is confined to the air sacs a progressive emaciation may be the sole indication of illness. Death may occur in from one to eight weeks from asphyxia or marasmus.

Lesions. These are found in the larynx, trachea, bronchia, lungs, and the air sacs of the soft parts, and less frequently of the bones. The nasal chambers are usually free. They consist of yellowish or greenish membranous patches on the mucosa, or round masses like tubercle, and bearing on their surface the mycelial filaments. The masses, which are found also in the diaphragm, liver, peritoneum and intestine, sometimes become caseated or calcified, intensifying the resemblance to tubercle. In pigeons they have been found in the mouth, of the size of a pea or bean. The formation consists largely of fibrinous exudate with leucocytes and often cocci or spores, but on the surface the fungus growth is easily demonstrated. In the solid organs the deposits may be easily confounded with miliary tubercle, coccidiosis or acariasis caused by the symplectoptes, but under the microscope the revelation of the aspergillus filaments and the absence of the parasites which cause these other diseases is diagnostic.

Pathology. The spore inhaled from the food or dust, and propagating on the mucosa or in solid tissues, interferes mechanically with the breathing and other functions and thus establishes its pathogenesis. It leads to local congestion, and exudation and establishes a positive chemiotaxis on the leucocytes, which are seen to accumulate around the growing fungus. Giant cells are often present, so that the histological relation to the tubercle is very close. Fibroid development may also take place in the masses and in these the filaments may disappear. Cultures of the aspergillus, injected into the axillary vein of a pigeon caused a pseudo-tuberculosis of liver and lungs with death in three to four days. Thrown into the trachea they caused death in ten to twenty days, with groups of pseudo-tubercles and numerous caseated centres.

Yet the aspergillus produces no very actively toxic product as shown by the experimental researches of Schütz, Kottiar, Lucet and Renon. They have moreover been found on the muscosa in healthy animals, and affected men have recovered when removed from fresh accessions of the spores, so that we may assume a power of resistance in healthy tissues, and a special susceptibility in a muscosa weakened by other diseases or by the presence of foreign bodies and other irritants.

Symptoms in Solipeds. As seen by Schütz, Rivolta, Martin, Lucet and Thary, the malady may be acute or chronic. There is great depression, dullness, and even trembling, with short, hurried breathing, and bloody nasal discharge. The pulse is accelerated, the heart action tumultuous and the temperature elevated (103° to 106° F.), there are the percussion and auscultation signs of pulmonary consolidation, and usually wheezing. There may also be signs of nephritis. A positive diagnosis can only be made by the recognition of the spores and filaments in the expectoration, by their culture in peptonized bouillon or on gelatine, and by successful inoculation on birds.

Acute cases may prove fatal in three days. Chronic cases may last for months with impaired appetite and breathing and finally marasmus.

Lesions. In the acute form there is found generalized hæmorrhage into the lung and respiratory mucosa. The hæmorrhagic areas may be individually two or three inches in diam-

eter and the aspergillus filaments are found in the center. Similar hæmorrhages have been found in the kidneys and intestinal mucosa.

In the **chronic form** the anterior lobes are splenized and of a dark red. The pleura is thickened and shows yellowish pea-like nodules, which have a necrotic centre with more or less caseated matter and aspergillus filaments.

Symptoms in Cattle and Sheep. Schütz, Röckl, Piana, Mazzanti, Lucet, Bournay, König and Hartenstein have recorded cases in cattle and Mazzanti, one case in a lamb. Hartenstein attributes to this fungus the catarrhal pneumonia of calves. The patient fails in appetite, rumination and, in dairy cows, milk. A feeble, hacking cough sets in with labored breathing and a double lift of the flank, and a grunt in expiration. The symptoms are essentially those of catarrhal inflammation which may be consulted. The one diagnostic symptom is the discovery of spores and filaments in the expectoration.

Chronic cases bear a strong resemblace to tuberculosis, but they do not respond to tuberculin tests.

Lesions. Sometimes the pulmonary lesions resemble miliary tuberculosis (Röckl and Piana), in other cases they reach the size of a walnut, and in others there is an extensive hepatization with more or less pleurisy. Klosterkemper noted a resemblance to actinomycosis. There is usually a circumscribed yellowish central mass made up largely of the mycelium, with more or less surrounding red hepatization. At times the exudate is so abundant as to distend the interlobular connective tissue, as in lung plague. Hæmorrhagic centres several inches in diameter are common in the lungs and the bronchial and tracheal mucosa is in a hæmorrhagic condition. In some instances the fungus has been found occupying old standing ulcers of the mucosa and the interior of vomicæ and ruptured abscesses. The air cells in the affected parts are usually filled with mycelium, and this appears to be a common starting point for the local growth. The adjacent bronchioles are filled with leucocytes, blood globules, and fibrinous coagula, and the epithelium has been more or less destroyed.

Symptoms in Dogs. A case described by Rivolta under the name of *mucorimyces canis familiaris* was probably aspergillus. The animal had a dry, frequent cough and accelerated respira-

tion and lameness in one hind limb. There was generalized sarcoma in the kidneys, lung, spleen and womb. In the centre of each nodule were filaments and round cells or spores connected in chains. No cultures nor inoculations were made so that the true nature of the fungus cannot be confidently affirmed.

Prevention. This will consist largely in the hygiene of the animals and buildings. Avoid shows and public collections of birds or other susceptible animals. Catarrhal and other affections of the respiratory mucosa should be treated with injections of sulphite or salicylate solution to remove any concurrent microbian cause of local debility and the tone of the general system should be kept as high as possible. Fodder suspected of containing the aspergillus should be discarded or watered with lime water or a solution of hyposulphite of soda. When it can be cut and boiled it may then be safely fed. Grain or mush may also be boiled. The stables or other buildings should be well aired and lighted, and their sites thoroughly drained. Dust baths containing lime, calcium sulphide, sulphur, or hyposulphite of soda will be useful. The walls, floors, nests, roosts, and ceilings should be treated with live steam or boiling water, or they may be covered with whitewash made from freshly burned quick-lime, or chloride of lime, or with a solution of mercuric chloride (1:500), or blue stone (1:200), and in addition they may be fumigated while wet with sulphurous acid or chlorine gas. All affected animals should be excluded and accessions to the flock or herd critically examined before admission. This is above all necessary under the *cramming* system of feeding, and for the sake of the attendant as well as the birds the system of feeding from the human mouth should be discarded. Burn or boil all carcases, litter and manure.

Treatment. Therapeutic treatment has been little tried but the best hope of success would be in cases in which the aspergillus is still confined to the respiratory mucosa. In such cases the non-poisonous fungicides may be inhaled, or injected in solution into the trachea. Sulphurous acid produced by the burning, in a close building, of a mixture of sulphur and alcohol, so as to saturate the air to such an extent as can be borne without violent coughing may be kept up for half an hour at a time twice daily. Great care is required, especially with birds, to obviate suffocation. The administrator must stay with the patients ready at

any moment to admit fresh air by opening doors and windows, when the line of safety is being exceeded. As a tracheal injection a solution of hyposulphite or bisulphite of soda (2 drs. to 1 quart water) may be employed. More irritating and dangerous, would be inhalations of formalin, chlorine, or iodine, or injections of these in solution. Cadeac advises inhalations of tar, phenol or oil of turpentine, or tracheal injections of solutions of phenol or salicylic acid. He even mentions sublimate, but surely as a lapse of judgment only.

It is always possible to raise a new healthy flock from the old by washing the eggs in boiled water, cooled, hatching them out in clean incubators, and raising the chicks on new uncontaminated ground, wild birds even being excluded.

Gutturomycosis Equi. See vol. I. p. 149.

MUCOR RACEMOSUS.

This representative of the **mucorinæ**, a close relative of the **trichophyton**, was found by Frank in a polypoid tumor of a horse's shoulder. The tumor lay under the upper part of the collar, by which it was often rubbed off, but it was as constantly formed anew. The cryptogam showed an abundant mycelium of large size, with globular conidia situated at its periphery, and resembling the mucor racemosus. So far as this contributed to the recurrence of the tumor, it might be remedied by the free use of a fungicide such as the standard solution of sulphurous acid protected against evaporation, a saturated solution of hyposulphite or bisulphite of soda, or the standard solution of iodine.

DERMATOZOA.

Coccidium oviforme: in epidermic cells, as round protoplasmic body, acquires outer coat, bursts epidermic cells, becomes segmented, sporulated, and finally falciform. Pathogenic to poultry, turkeys, pigeons. *Symptoms:* Unfeathered parts of head, etc., forms wart-like nodules, grain-like, yellow. In pigeons, umbilicated, suppurating, ulcerating, fœtid. May dry, disintegrate, desquamate, heal. May cause anæmia, emaciation, marasmus, death. In rete Malpighii, follicles, gland ducts. Contagious directly and indirectly. *Treatment:* Caustic, oil of turpentine, oil of tar. Disinfection of buildings.

Cutaneous Coccidiosis. (Psorospermosis). Molluscum Contagiosum. Epithelioma Contagiosa. Poultry, turkeys, pigeons.

Coccidia Oviformes. Live mainly in the epidermic (elsewhere epithelial) cells. First, small *round protoplasmic masses, usually nucleated.* These encrease in size, acquire a *cyst* or shell, and burst open the epithelial cell-hosts, escaping to the epithelial intervals. Then they become *segmented*, their protoplasm condensed and then divided into several *spheroids* (**spores**). Each spore divides into several **falciform corpuscles,** which invade new epithelial cells and repeat the above transformations.

Symptoms. Attacks especially the head, beak commissures, nostrils, eyelids, auditory meatus, comb, barbs. Forms oblong, salient, wartlike nodules, sulphur yellow, in size from a linseed to maize grain. In pigeons attacks head, lower surface of neck and body, and rump, and the upper surface of the wings near the root of the pin-feathers. The nodule at first firm and resistant, soon becomes degenerated and forms a thick central yellow debris in the now umbilicated centre. In pigeons may cause suppuration or ulceration, with a fœtid odor. Recovery may be spontaneous, the nodules drying up, disintegrating, falling off and leaving healing sores. In other cases disease extends, with anæmia, emaciation and marasmus, to a fatal result. This is especially so in pigeons when the disease extends to the mucosæ. It grows especially in the *rete Malpighii*, but also extends into the follicles and gland ducts (follicular psorospermosis). Is contagious from bird to bird by direct contact, by roosts, solid bodies on which they rub the affected bill, etc., and by infected dust. To fowls and pigeons by experimental inoculation (Pfeiffer).

Treated successfully by the hot wire, by oil of turpentine, by oil of tar.

Buildings should be thoroughly disinfected by quicklime and mercuric chloride. See vol IV, p. 202.

WHITE DIARRHŒA OF CHICKS. INTESTINAL COCCIDIOSIS IN BIRDS. TYPHLITIS COCCIDIOSA.

This disease so destructive to chickens and turkeys in America and Europe, often cutting off 60 to 75 per cent of the encrease, has been traced by Mohler and Morse to the well-known *Coccidium tenellum* or other coccidia. From their observations it would appear that not only *white diarrhœa* in chicks, but also *limberneck*, *going light*, *leg weakness*, *black head* (*entero-hepatitis*,) and *enteritis* in squabs are all alike dependent on an invasion of different organs by the *Coccidium tenellum* or other Coccidium.

Coccidium tenellum as found in the intestines of birds is a round or ovoid mass of protoplasm 12 to 15 μ. in diameter containing a granular protoplasm filling the entire cyst or shrunken from its walls, and with or without a nucleus. It may be assumed to follow the course of the C. oviforme in its development, the protoplasm developing two (later four) protoplasmic spheroid bodies (spores), each forming two sickle-shaped bodies having the enlarged or nodular swellings at opposite ends of the structure. The falciform bodies burst their way out of the epithelial cell and by amœboid movements enter others in which they repeat the same process of evolution.

Symptoms. Birds of any age harbor the parasite, but the fatality is largely restricted to young chicks, from two to five weeks old. These show dullness, weakness, separation from their fellows, a disposition to sit much of the time, leg weakness, unsteady gait, impaired appetite, and the passage of a white pasty fœcal discharge, merging into a more or less liquid diarrhœa. Microscopic examination of the droppings will reveal the presence of many spheroidal or slightly ovoid protozoa, or again the falciform bodies, free, or inclosed in the more or less swollen or disintegrated epithelial cells. The enzoötic manifestation of the disease in the warm seasons, confined to one poultry house, run, or locality, the pronounced muscular and nervous adynamia, and the semiliquid or liquid, chalkwhite stools, occurring mainly in the very young, should demand a microscopic examination for the protozoa in the fæces.

Lesions. On post mortem examination the most prominent lesions are concentrated in the cæca which are swollen and distended with a yellowish white caseated material, while the walls are mostly thickened, yet with destructive, ulcerous changes of the mucosa, and even of the muscular and peritoneal coats so deep in some places as to allow escape of the caseous contents into the abdominal cavity. The other portions of the intestine are not exempt from invasion, and other organs, the lungs especially, are often involved. The cæcal contents and mucosa consist largely of granular debris, epithelial cells in various stages of disintegration, the large permanent coccidian cysts, and other microörganisms. The lung lesions similarly consist of the coccidia in clusters (nests), and in distended epithelial cells charged with coccidia in process of evolution and of much granular debris, the whole forming a whitish caseating mass that might easily be mistaken for a tubercle. These centres of caseation, though often small and discrete, frequently become confluent, so as to involve a large portion or apparently almost the whole lung in one extended mass of caseation.

Mature hens also harbor the coccidia in the intestinal contents and mucosa and as globular white deposits in internal organs or in connective tissue but habitually without the same acute or dangerous symptomatic phenomena.

Treatment. As a forlorn hope Morse suggests to give each chick $\frac{1}{10}$ grain Calomel, or a few drops castor oil with 1 to 3 drops oil of turpentine, also that 5 to 10 grains iron sulphate be disolved in each gallon of drinking water. Cupric sulphate might replace the copperas.

Prevention. The coccidia tend to invade different internal organs beyond the reach of medication, so that the most effective measure consists in raising a new flock from sterilized eggs hatched in an incubator. The eggs receive coccidia upon their shells while passing through the cloaca, and as there is no barrier to the coccidia passing up the oviducts, they can thus gain access to the albumen of the as yet crustless ova as well and lay the foundation for infection of the coming embryo. The organisms on the shell may be removed in whole or in part by washing with distilled or boiled water or, as Morse suggests, by sponging with 95% alcohol, which evaporates without doing in-

jury to the germ. Eggs with coccidia in the albumen cannot be so disinfected and will allow or ensure the conveyance of the disease to the coming embryo. Infection of the oviducts therefore is a barrier to this method of prevention. To insure success in other cases, the incubator must be thoroughly cleansed, scalded and washed with a solution of cupric sulphate, mercuric chloride or formalin. Or the surface may be flamed or subjected to live steam. A similar treatment is demanded for the brooders, nurseries, and pens into which the newly hatched chicks are admitted. The soil to which the chicks have access should be freely treated with a saturated solution of cupric sulphate, or covered with freshly burned quicklime, and dug up and left for a time exposed to the sun.

Natural hatching under a hen which has been treated for intestinal coccidiosis has been attempted, but in an infested flock, one cannot hope for anything like a constant success in this way.

INTESTINAL COCCIDIOSIS IN TURKEYS AND PEA-FOWL. INFECTIOUS ENTEROHEPATITIS. CAECAL COCCIDIOSIS. BLACK-HEAD.

This deadly affection of young turkey poults and by Th. Smith attributed to the Amœba Meleagridis (See Vol. IV), has been traced by Doflein, Prowazek, Neuman—Macqueen, Kaestner, and Morse to **coccidium tenellum**. As described in Vol. IV, p. 432, this is most destructive to the young (unfledged and fledglings), yet is harbored and transmitted by mature birds as well, by soil and water where these birds run, and through the eggs that they lay. The disease is transmitted to turkey poults by infected chickens, their runs, waters, houses, etc. (Curtice.) The affected birds droop, become shrunken and emaciated, leave the flock, have diarrhœa (mucous or bloody) while the coccidia in the cells of the mucus or watery discharges betray the nature of the disease. The bare skin of the head and neck (gobble, caruncles) becomes the seat of coccidian propagation with congestion, swelling and local necrosis, the whole assuming a black color from which the common name (*blackhead*) is derived.

On necropsy the cæca are found to be swollen and thickened

with mucosa more or less necrotic, and the contents of a whitish or yellowish caseated aspect, the cells and intercellular material abounding in the rounded, ovoid, or crescentic coccidia. Coccidian colonies are also found in other internal organs, notably the intestinal mucosa, and live with circumscribed areas of congestion, and necrotic degeneration.

Treatment. Morse claims successful treatment, even in the midst of infected flocks by a daily morning pill of ½ grain copperas, and a nightly 2 or 3 grains pill of sodium salicylate.

Prevention may be undertaken along the same lines as in intestinal coccidiosis of chickens. A legal penalty should attach to the transfer of live birds from infested flocks or runs.

INTESTINAL COCCIDIOSIS OF PIGEONS. COCCIDIOSIS OF SQUABS.

In no kind of birds is coccidiosis more destructive than in the pigeon, whole pigeon houses, or squab lofts, being often depopulated in a few days by the plague. The old pigeons as well suffer in the infested cots, or localities, and the extreme fatality may be largely attributed to the transfer of the infected secretions of the crop of the parent bird to the mouth and intestinal tracts of the young. The phenomena shown in the old are mainly those of intestinal catarrh with occasional diarrhœas. Encreasing emaciation, marasmus, leg and general weakness, are followed by death. In the most acute cases birds that appeared well at night are found dead in the morning with lesions recalling hæmorrhagic septicæmia.

The *post mortem lesions* are those of extensively diffused intestinal congestion and enteritis, the epithelial cells and muco-purulent products being heavily charged with coccidia. The remarkable thickening and necrosis of the walls of the cæca and other intestines are much less in evidence in squabs than in chickens and turkey poults.

Treatment and *prevention* should be sought along the same lines as in chickens and turkeys.

INTESTINAL COCCIDIOSIS IN DUCKS.

Leg weakness and paralysis in ducklings is doubtless in many cases due in part to the commonly invoked conditions of "weak germs" "too early mating of young," "inbreeding" "musty food," "excessive heat of brooders" etc., but G. B. Morse has found on microscopic examination that a large number of these fatalities depend on an extensive invasion of the bowels by coccidia. The correcting of any fault in breeding, dietetics, or hygiene therefore must be supplemented by such measures as are advised above for the destruction and extinction of coccidia.

AMŒBOID DISEASE OF FEET, ETC., IN LAMBS.

Protoplasmic masses in epidermic and epithelial cells in rete Malpighii, lips, gums, nostrils, coronet. Suppuration, emaciation, death, or desiccation, desquamation, recovery. Amœba princeps grows in water. *Treatment:* Quicklime, cupric, or ferric sulphate, stibium chloride, oil of tar, etc.

Leudenfield found epithelioid concretions and growths on lips, gums and nostrils and behind the hoofs in lambs. The rete Malpighii was inflamed, proliferated, and thickened, the hypertrophy extending outward to the horny layer and inward to the papillæ of the derma. Beneath this, suppuration might be found and the patient might run down and die, or the morbid product might be dried up and thrown off, followed by recovery.

Beneath the horny layer Leudenfield found granular nucleated masses which he identified as Amœbæ: these seemed identical with **A. princeps** (Ehr.) of fresh water, and he supposed the lamb contracted them from pools and mud holes. They could be cultivated readily in water.

Treatment would be by dusting with quicklime, or by a lotion containing turpentine, oil of tar, creolin, lysol, cupric sulphate, ferric sulphate, butter of antimony, etc.

DIPTERA, FLIES. TWO-WINGED INSECTS.

These are hexapod, developed through a grub-like larva living in water or moist media, and advance through a pupa into the mature fly. The following are parasitic or predaceous:

MOSQUITOES. CULEX. ANOPHELES.

Culex pipiens, C. Equina, Anopheles, characters, larvæ. *Prevention:* Curtains, "smudge," parasiticides, drainage, kerosene or phenol in water, or fish or frogs in it, remove brush, plant belts of trees. Locally on bites: ammonia, phenol, sodium carbonate, potassium permanganate, lead acetate.

The *culicidæ* or *gnats* are represented by the common mosquito, **culex pipiens**, the female of which attacks man and beast, mostly at night, piercing the skin with the stylets of its rostrum and not only sucking blood, but instilling a poison which produces active inflammation, itching and swelling. The **culex equinus** is especially troublesome to horses, and the **anopheles**, characterized among other things by the black spots on its wings, is remarkable for inoculating the protozoa that cause malarial fevers. The stegomyia carries the protozoön of yellow fever.

The culicidæ are characterized by a long slender body (5 to 6 mm.), by the fourteen-segmented antennæ, by the thick bulging thorax, by the large head and the prolonged rostrum containing six perforating lancets. The legs are long and delicate, the wings long and narrow and produce a singing note in flight. The larvæ known as wrigglers (wigglers) are found in pools and other stagnant bodies of fresh water and damp ground on which the parent lays her eggs.

Prevention. The attacks of the mosquito are warded off by mosquito curtains, by *smudge*, the patient standing or lying in the dense smoke of burning green grass, by insect powder. inside screens, or by covering the skin by parasiticides offensive to the gnat. To prevent their reproduction the drainage of ponds, marshes and damp soils is the most effective measure, or when this cannot be accomplished the sprinkling of kerosene or phenol on the water in which they breed, or by adding aluminum sulphate or by propagating frogs or fishes in the water. Shrubbery, brush and dense foliage harbor the gnats, to come out in swarms at night, yet a belt of woods between the breeding places and the higher grounds will largely protect the latter against invasion. This especially applies to anopheles, which are weak in flight and don't travel much over 100 yards unless blown by the wind. To lessen the itching of the bites solutions of ammonia, phenol, sodium bicarbonate, potassium permanganate, or lead acetate may be applied.

SIMULIDÆ. BLACK FLIES.

Adirondack black-fly; turkey gnat; buffalo gnat. Sometimes fatal. Abound in low, damp lands, brush and woods. *Prevention, etc.*, as for mosquito.

The **simulium** is shorter than the **mosquito**, with a thick broad abdomen, a short thick thorax, antennæ with 11 segments, and probosis with two perforating stylets, the wings are wide and short and the legs thick and stout. Among the most troublesome American species are the **Adirondack black fly** (*S. Molestum*), the **turkey gnat** (*S. Meridionale*), which drives the bird from its nest, or pesters it to death, and the **buffalo gnat** (*S. Pecuarum*), which harasses and even kills cattle. The first is the worst pest of the visitor in the North Woods, the second pesters the turkey until it leaves its eggs, and all bite and suck the blood of their victims, often causing death even in the larger mammals. In Lapland they drive the reindeer from the lower rich pastures to the mountain glaciers for protection, in Hungary, Servia, Moravia and Austria they cause heavy losses of horses, cattle, sheep and swine, and even in some damp regions (Fens, etc.) of England they prove most injurious. They abound on low, damp lands, among brush and woods and are to be met by the same measures as the mosquito. Solutions of quassia, tobacco, or walnut leaves, and liniments of oil of tar are often employed.

ASILIDÆ: ROBBER FLIES. TABANIDÆ, HORSE OR OX FLIES.

Hornet asilus; Tabanidæ; their pertinaceous and injurious bites. Hæmatopota, Crysops, Pangonia, Rat-tailed—Eristalis Tenax.

The **hornet asilus** (*A. Crabroniformis*), easily recognized by the hornet-like constriction of its body, is one of the most predaceous and troublesome of insect pests.

The **tabanidæ**, horse flies, are remarkable alike for their large size, the breadth of the somewhat flattened body, for the compression of the head from before backward, for the 3 articled antenna the last segment annulated and devoid of hairs and for the perforating lancets in the rostrum of the female for purposes

of blood sucking. The male, like that of the mosquito lives on vegetable juices. The larvæ live in earth or water and are carnivorous, subsisting on the larvæ of other insects, etc.

The female tabanas attacks the large animals, wild and tame, and even man himself. It flies with a buzzing noise and with extraordinary speed, catching up with the swiftest victim, and alighting on the most delicate parts of the skin, which it instantly perforates and sucks blood until gorged. When it leaves a drop of blood is left to dry and a temporary swelling marks the spot. They are justly charged with conveying infection from animal to animal.

There are several hundreds of species, the most familiar of which are named in the list of diptera given above.

HÆMATOPOTA (bloodsucker), CHRYSOPS (golden eyes), PANGONIA.

The **hæmatopota,** a division of the tabanidæ, are among the most fierce in their attacks, and once settled, allow themselves to be killed rather than give up their bloody feast. The smallest, **H. Pluvialis,** about ⅓ inch long, flies especially after a shower. **H. Tenuicornis** and **H. Grandis,** the **Clegg** of North Britain, are equally predaceous. The **chrysops** is named from the golden yellow reflection from its eyes, which are multiplied by three additional. **C. Cæcutiens (blinding breeze fly)** has the habit of settling on the eyes and eyelids. It is 9 mm. long, with brown wings, wide apart, and each marked by two spots, anterior and posterior; abdomen flattened and gray with a yellow ring at the base. About 50 North American species are described. A **Pangonia** preying on cattle in New Caledonia is charged with propagating anthrax, a charge applicable to all flies preying on animals, and to most contagious diseases.

ERISTALIS (DRONE FLY). HELOPHILUS (MARSH FLY)

The family of **syrphidæ,** characterized by a tail-like prolongation in the larval state (**rat-tailed maggots**) is represented by **Eristalis Tenax** and **Helophilus Pendulinus** which not only

attack the horse but are found present as larvæ in horse manure, and have therefore been credited with living in the intestines.

MUSCÆ (HOUSE FLY AND ALLIES).

Muscæ don't bite, but suck and through their numbers and irritation may cause sores. Horn fly, very injurious.

The genus *muscæ* are not furnished with perforating stylets, but only a soft sucking proboscis, by which they imbibe perspiration and the exudations of wounds and abrasions. On the sound skin they cause irritation by their numbers and persistence, the itching or formication being most annoying to an animal that is nervously sensitive. On wounds, however, they are irritating by their constant titilation, and by the transfer of infection not only from wound to wound, but from putrid organic matter to wounds, and from wounds to food and water. They lay their eggs in collections of manure, (especially horse manure) and in decomposing organic matter, in which the larvæ are produced. The common species of muscæ are named in the list of diptera.

The **Hæmatobia Serrata** or **Horn Fly** has lately spread over North America causing great irritation to cattle and especially around the horns and head. Its suctorial proboscis is not piercing, yet by their numbers and the persistency of their attacks these flies may produce extensive lesions of the skin. The eggs and larvæ are found in cow manure and their reproduction must be arrested by applying lime and other agents to the dung.

GLOSSINA MORSITANS. G. PALPALIS. G. TACHINOIDES. "TSETSE."

"Tsetse," an African fly causing infection of nagana especially.

The fly first named is a little larger than the house fly, with a proboscis twice as long as the head and its piercing stylet barbed, its thorax orange with four black lines, and its abdomen yellowish white with black spots on the four last segments. The wings are smoky. It prevails along damp lands and river bottoms in Central Africa. It attacks man and beast, striking them like a

flash, and instantly perforating the skin and drawing blood. Livingston, Oswald and others considered its bite fatal to all domestic animals except the elephant, the ass and the goat, the symptoms being a spreading tumor in the seat of the bite, and progressive and fatal emaciation and debility. Later observation by Baur, Nocard, Leroy, Bruce, and Megnin show that the bite in itself is not dangerous nor fatal, but that this, like other blood sucking flies, becomes the medium for the transmission of fatal infections, in this case the Trypanosoma Brucii the true cause of *Nagana*, and that only those animals that are insusceptible to these infections survive.

The **Glossina palpalis** carries the trypanosoma of sleeping sickness in man, also that of *Baleri* of horses, cats and dogs on the Bani branch of the Niger, also the *Souma* to which dog, ape, Guinea-pig, horse, ox, sheep, goat and pig are susceptible. G. tachinoides, Tabanus, and stomoxys are also incriminated. Baleri causes dropsy of sheath, lower limbs, etc., with death in 2 to 5 months (dog 5 to 15 days). The G. palpalis frequents underbrush and shade and preys mainly on the blood of aligators. Koch proposes a bounty on aligators' eggs to exterminate the fly. As the fly frequents bushy shady places only, the removal of all trees in and around villages is advocated.

LARVÆ OF DIPTERA IN WOUNDS. FLY BLOW, MYIASIS.

Blowflies with larvæ on dead meat, sores, or soiled skin or wool. Sarcophaga Magnifica : larva on horses, oxen, sheep, swine, dogs, camels, birds. Lucilia Serricata : larva on sheep in Holland and England favored by damp climate. *Symptoms:* leaves flock, mopes under bush, etc., dark wet patch on tail or hips, wriggles tail, rubs, bites, tears out white tufts, open sores or subcutaneous galleries show abundance of maggots, all sizes ; death in 24 hours or longer. L. Macellaria : Screw-worm ; worst in warm latitudes ; attacks horse, ox, sheep and swine on soiled skin or wound. Cayor fly. *Prevention of fly-breeding :* drainage, kerosene, etc., on water, fish or frogs, have dark-covered pits for manure, add copperas, etc, turn over cow manure in field, add parasiticide. *Remove fly-shelter*, brush, weeds, coarse grass tufts. *Exclude flies*, darken building, screen, admit light on one side only, admit air through bent tubes, enter the animals one by one through a dark stall with light in box at ridge, and brush them. *Kill flies in building* by smoke from green vegetation, by chlorine, insect powder, or

quassia or tobacco water ; trap them in glazed lighted box in wall of dark stable, etc. *Protect animal's body* by linen sheets, nets, decoction of walnut leaves, tobacco, ailanthus, quassia ; for sheep expel intestinal worms, remove soiled or wet wool, and apply parasiticides, creolin, oil of tar, naphthalin, scrape out maggots, use phenated camphor, etc.

The larvæ of the blowflies of dead meat. **Sarcophaga Carnaria, Cynomyia Mortuorum** and **Calliphora Vomitoria** (*Blue Bottle*) have not been proved to attack living animals. The **Sarcophaga Magnifica**, however, the **Lucilia (Campsomyia) Macellaria,** (*Screw-worm*) the **L. Serricata** and the **Achromyia Anthropophaga** (*Cayor Fly*), raise their larvæ on sores.

Sarcophaga Magnifica is of grayish ash color, the head broader than the thorax, the vertex, front and palpi black, the face of a silvery white, and the legs black. The length is 10 to 13 mm.

Megnin has found the larva of this fly most common in wounds of man and domestic animals in Europe giving rise to great destruction of the tissues in horses, oxen, sheep, swine, dogs, camels, and birds. It attacks also the natural cavities as the nose, mouth, sheath, interdigital canal, etc.

Lucilla Serricata is smaller than the blue bottle fly, has a greenish blue tint, with white face and epistoma, and the first ring of the abdomen black.

The "fly-striking" or "maggot" in sheep in Holland has been traced to this fly. The usual point of attack is the tail or hips when sheep have been scouring because of food, or intestinal worms, but they will select any part of the body which may have become wet and soiled by lying in manure, or soaked by reason of skin disease, heavy rains or otherwise. The most common cause is diarrhœa determined by entozoa, hence in all cases of "fly-striking," especially in lambs, worms should be suspected. The proximity of trees, bush or other shelter for the flies should also be taken into account. Hot, damp showery weather is a common accessory. In spite of Neumann's assertion to the contrary, well conditioned sheep suffer as well as the badly kept. The wet climate of the British Isles and Holland strongly favors these attacks.

Symptoms. In summer and autumn, when the flies abound, sheep should be seen and critically examined twice a day. One that has left the flock, to mope under a bush, is to be strongly suspected. One soiled about the tail and hips or elsewhere, one showing a dark patch on the uniform gray of the fleece, one with tufts of white drawn out by rubbing or biting, one showing a disposition to bite or rub itself, or a constant shaking of the tail is probably attacked. When caught and examined the wool over the affected part is dark and closely matted, and in its roots, or in raw worm-eaten sores, or in cavities under the derma, to which small sores open, are found the maggots in myriads and of all sizes, with two hooklets on the head and three stigmata on the tail. When badly affected death may ensue in twenty-four hours.

Lucilia Marcellaria. **Campsomyia Marcellaria** is 9 to 10 mm. long, with a bronze blue thorax, traversed from before backward by three darker purple blue lines, and black legs. The wings are brown at the base. The larvæ (14 to 15 mm.) are smaller than those already described, yet very destructive.

This is little known in the Northern States, but in the Middle and especially in the Gulf States it becomes most injurious or fatal. It is common from this south to the Argentine Republic. The flies deposit their eggs in wounds, on soiled surfaces, on the perspiration inside the thighs and elbows, in the sheath and other cavities. With their buccal hooklets the larvæ lacerate the skin and burrow into the raw sores so that if neglected, they soon reach a fatal extension. This fly is very predatory attacking man and beast with equal readiness. Horses, cattle, sheep and swine suffer indiscriminately, the main accessory factors being the soiling of the skin by diarrhœa, manure, rains, dews, perspirations, and other secretions, and the shelter afforded to the fly by brush and foliage.

In Cuba an unnamed fly, possibly the Macellaria or **Sarcophaga,** deposits its ovum or embyro on the lips of the calf. The larva lodges in the gum, eats its way into the tooth socket, and burrowing deeper into the gum causes great destruction of tissue and even fatal results.

Ochromyia Anthropophaga (ochros yellow, anthropos man, phagein eat). CAYOR FLY. This fly, a native of Senegal, has a grayish yellow body, with two longitudinal black bands on the

thorax and black spots on the abdomen. The head has a hard crustaceous covering and with the antennæ is hairy. The wings are slightly smoky. The eggs are deposited in the sand where animals lie, yet the larvæ supposed to be those of this fly are found in small tumors in the fat and other parts of the body of man and animals (dog, cat and goat), where they mature and in six or seven days drop out, become a pupa, and finally a mature fly. Young animals suffer most, sometimes fatally.

To Prevent Reproduction of Diptera. Diptera which pass through their larval stages in still water or moist earth (mosquitoes, blackflies, breeze flies, tsetse) can be largely controlled by drainage. When this is not feasible then myiacides, like petroleum, kerosene, oil of tar, oil of turpentine quick lime, aluminum sulphate added to their breeding pools will cut them off in the larval stage without rendering the water poisonous to stock. In the case of muscæ, which breed largely in horse manure, one should avoid such decomposing material in the vicinity of buildings, or mix it with kerosene, phenol, copperas, alum or other agents that will kill the larvæ.

Dusting the breeding-places and material with calcium sulphide, potassium sulphide, iron or aluminum sulphate, mercuric chloride, powdered tan bark, insect powder, or any of these agents slightly impregnated with oil of tar, phenol, tar water, cresol, creolin, napthalin, etc., will arrest their encrease.

For the horn fly which breeds in the manure of cattle the droppings in the fields may be turned over or treated with the agents just referred to.

In case of Lucilia Serricata and other flies which lodge ova or other embryos on wet, foul skin or wounds and in open cavities, isolate the affected from the unaffected and treat them. Burn carcases.

Remove Shelter of the Diptera. In all cases the removal from pastures of rank branching weeds, and above all of low dense brush, is a valuable measure in doing away with the shelter which the flies naturally seek and from which they emerge to attack animals as they approach. Tall spreading trees with bare stems are less objectionable as the flies prefer to keep near the ground where they are on a level with their victims.

Exclusion of Flies from Buildings. By keeping the interior of the building perfectly dark, diptera which fly in the daylight are driven out. This, however, excludes the purifying agents, air and light. Fly screens over windows, doors, and other openings may be made so secure as to exclude the pests, and in the case of the musquitoes this is now proved successful and protective against ague and yellow fever. Yet they seriously interfere with the free circulation of air. Spence says that in Italy the light is admitted on one side only of a building, and the windows covered with a screen or net with wide meshes through which the flies could easily pass. This imperfect obstruction and the dark background combine in deterring flies from entering and in tempting out those that have already gained admission. If light is admitted on the opposite side of the building the flies continue to enter freely, An analogous resort, which would not interfere with the circulation of air, would be to admit fresh air below through tubes so bent that the light of the interior would not be seen and they would appear as dark passages; then have the outlets in the ridge or under the eaves, similary bent, and covered at their inner opening by a detached screen which would exclude from the ventilating outlet any light coming from the interior of the building.

An excellent resort is to reverse the position of the window sashes, placing the lower sash in the outer groove, and the upper in the inner one. Then when the lower sash is raised, and the space below closed by a wire screen, the only entrance for the flies is between the two sashes and from without downward and inward, a direction the reverse of that usually taken by a fly. The result is, that few, if any, will enter the room by this way, while the flies, already inside the building, following their natural attraction towards the light, crawl upward on the inner side of the outer (raised) sash and escape over its upper border into the outer air. In this way not only are the outside flies excluded, but those inside are attracted to pass outward and the room is gradually cleared of the pests.

The trap may be made even more effective by fixing a second wire screen to the window frame on the inner side of the upper sash, and extending downward over one-half or two-thirds of its area. Then the upper sash may also be opened for ventilating

purposes and the room flies alighting on its inner surface, instinctively crawl upward and make their escape into the outer air over its upper border.

The same principle can be availed of to kill the flies carried on animals and prevent them from entering buildings with stock. A small building is made capable of holding one animal, without window and with double doors at each end, closed by springs so as to keep the interior perfectly dark, and having an opening in the ridge leading into a close box having glass on four sides. Each animal is passed through this and the flies, swept off by a brush or broom, at once ascend to the light in the small glazed chamber where they accumulate. When all the stock have passed through, the flies in the glazed box can be destroyed by the spray of tobacco or quassia water, or the fumes of burning sulphur, tar, pumpkin leaves, etc.

To Destroy Flies in the Buildings. This may be accomplished in the absence of stock, by thorough fumigation with smoke from pumpkin leaves, green grass or vegetables, tar, turpentine, or sulphur; by filling the closed building with chlorine gas or prussic acid; by dusting the whole building with insect powder; or by spraying the interior with quassia or tobacco water.

The flies' love of light may be availed of by making one small opening into a tight glazed box and then closing doors and windows to make the stable quite dark. The flies will gather in the glass box and may be destroyed as suggested above.

Even when the animals are stabled, bundles of ferns, grass, evergreens, etc., may be suspended at intervals from walls or ceiling, and at night, when covered with flies, they are burned or shaken over a fire.

Fresh chloride of lime set around in saucers will do much to drive out the flies. Sweetened quassia-water in dishes will kill the flies without endangering larger animals. Sticky fly paper and fly traps may be employed. Railliet advises to have two boards hinged together so that they will hang apart like the two limbs of an inverted Λ, to smear the inner sides with syrup, hang it on the stable wall and whenever one passes to close it suddenly and crush the flies.

To protect the bodies of Animals in Stable and at Work. The bodies may be covered by thin linen sheets. The common covers of netting or of leather thongs are still better as leaving the skin free to the air and for evaporation. A long fringe of twine or leather does much to encrease the protection. Netted ear caps are of most essential value. A simpler resort is the use of leafy branches attached to the harness, and moving with the motions of the animal.

Skin applications which are obnoxious to flies are also used. A decoction of walnut leaves, or of tobacco (3 ozs. to 1 qt.) rubbed on the skin once a week ; the fresh leaves of these plants rubbed on the skin ; the leaves of ailanthus ; infusion of quassia, aloes, or asafœtida ; creolin (5: 100) ; oil of cade ; oil of laurel ; oil of tar in oil (1:10); napthalin (1:10); chloro-naptholeum (1:20); camphor and asafœtida, etc. Petroleum or kerosene with a little oil of tar may be sprayed over the back twice a week for the horn fly.

Myiases of sheep should be guarded against by clearing worms from the bowels, by docking of lambs, by clipping of soiled wool from tail and hips, and by the application to these and other damp places of an antiseptic solution (creolin, oil of tar, naphthalin, chloro-naphtholeum, carbolic acid or other such agent). The same agents may be used for destroying the maggots (larvæ) that are already present in the wounds, but it is very essential to scrape these out from their deepest recesses, so that the deeper ones may not escape the myiacide. These agents may also be applied to the larger animals inside elbow or thigh, in the sheath and elsewhere where sweat or sebaceous secretions accumulate. In the case of the screw worm calomel is a common resort, and has the advantage of being somewhat stable and not readily evaporating. It may, however, be taken into the system in undue amount especially in cattle and could be safely replaced by naphthalin, asafœtida or camphor with oil of tar, or even crude tar water.

Sarcophaga Regularis. Viviparous. When confined with a goat, deposited its embryos in the nasal passages, where the large number of larvæ caused serious illness. F. C. Wellman, J. of Med. Res. 1906.

HYDROTÆA METEORICA. METEORIC FLY.

This belongs to the flies that have no coverings (elytra) for their balancers or posterior wings. They affect damp grounds, and are especially active on the approach of rain when they appear around the eyes and nose of horses in dense swarms. They have a soft proboscis which cannot pierce the skin, yet by their great numbers, and the itching and rubbing which they cause, they can determine considerable irritation and even abrasion.

HIPPOBOSCIDÆ. PUPIPARA. LOUSE FLIES.

No eggs laid; pupæ produced. All parasites on warm-blooded. Wingless or loose wings. H. Equina, H. Taurina, and H. Canina, cling to bare skin.

This family is distinguished by the fact that they do not lay eggs nor even larvæ, but produce pupæ or nymphæ. They are all parasitic on mammals or birds, living like lice on the skin, and are either wingless or often lose their wings on arriving at maturity.

Hippobosca Equina, 8 mm. in length, with brown thorax showing three yellow spots, two anterior and lateral and one posterior and central, yellowish brown abdomen, and yellow head well detached from the thorax. The legs are strong, yellow and bear terminal hooklets. The body is hairy. The oblong, smoky wings are permanent. This attacks horses, cattle, dogs and other animals. Rondani describes two varieties, **H. Taurina** which especially pesters the ox and **H. Canina** which attacks the dog and other animals.

These attack particularly the bare, smooth parts as around the vulva, anus, perineum, sheath, and inside of the thigh, moving rapidly over the surface and greatly irritating sensitive animals that are not inured to them. They remain adherent to the skin, will not be driven away, especially from animals with dirty skins. They are to be dealt with like other flies.

MELOPHAGUS OVINA. LOUSE FLY. (SHEEP TICK?)

A hippobosca : not a tick. Has six legs, is wingless, has distinct thorax and abdomen, perforating blood-sucking proboscis, pupa stuck to wool, young melophagus emerges in four weeks. Most abundant on debilitated, coarse-wools ; migrate from shorn to unshorn (ewes to lambs). Instil venom which checks coagulation. *Symptoms :* Rubbing, scratching, biting, white wool tufts ; parasites exposed by parting wool, near surface (summer) or near root (winter). *Treatment :* Sheep dips as in acariasis.

Though familiarly known as the *sheep tick*, this is not a tick at all but a hippobosca which has acquired a parasitic habit and permanently lost its wings, A mature tick (ixodes) has eight legs, whereas the melophagus has but six. The tick has an undivided, non-articulate body, while the melophagus is articulate, and has thorax and abdomen separated by a deep constriction. The adults are 3 to 5 mm. long ; brown body with spots on the oval abdomen ; head inserted into the thorax ; antennæ short forming tubercles ; proboscis tubular and toothed at the end, adapted to perforate the skin and suck blood ; legs stout, covered with hairs and each terminated by a hook. On each side are seven stigmata or breathing orifices. The female produces her young, one at a time, as a pupa, sticking the pupa case to the wool. From these the young emerge in the course of four weeks.

They are found especially on long-wooled sheep, the fine wools affording them too little freedom of movement. Though often abundant on the weak and ill-conditioned, they may be found on the most thrifty. After shearing they tend to leave the shorn for the unshorn or the lambs, where they can secure better cover.

They live by drinking the blood of the sheep proving injurious both by irritation and depletion. They will draw blood from man, secreting at the same time a venom which causes swelling and irritation four days later, and which may check coagulation of the blood while being drawn (Curtice). The plumpest specimens perish under four days when deprived of blood, their normal food (Curtice).

Symptoms consist in rubbing, scratching or biting, exceptionally wriggling of the tail and the loosening and exposure of white tufts of wool. When present in moderate numbers only, symptoms may fail ; when in large numbers unthriftiness, emaciation

and debility may be present. On parting the wool the melophagus can always be seen, in warm weather near the surface, and in cold near the roots of the wool.

Treatment consists in the use of sheep dips which will destroy the parasite. One of the best is the tobacco dip : (tobacco 16 lbs., oil of tar 3 pints, soda ash 20 lbs., soft soap 4 lbs., water 50 gallons. Sufficient for 50 sheep. Use at 70° F. and work well into the wool). Any effective dip used for **scab** may be selected. The lime and sulphur dip, and the carbolic acid dip have a slightly injurious effect on the wool, the mercurial dips injure by absorption, and both these last and the arsenical dips cause accidental poisoning through being taken into the stomach.

Both sheep and lambs should be dipped immediately after shearing, and turned into yard or pasture where no sheep have been, and where neither the mature parasite nor the pupa can be found. To be effective, it is desirable to repeat the dipping in one or two weeks to kill any that have escaped the first dipping through being in the pupa stage, and that have hatched out since. In extreme cases a third or even a fourth dipping may be called for, but if thoroughly worked into the wool with the hands and washed over the head this is not probable. Newly shorn sheep may be passed through the bath more quickly, but those with heavy fleeces may require one, two or even three minutes of active manipulation to saturate the whole mass. In this way the parasite may be permanently eradicated from a flock of even long wooled sheep. See *Acariasis*. To prevent its introduction anew it is important to keep them well apart from other sheep and the places where they have been within a few weeks. Newly bought sheep, those that have been carried in cars or other public conveyance, that have been in public stock yards, on highways traversed by sheep, or at public exhibitions should be dealt with like infested animals and dipped or freely sprinkled, in partings of the wool, with insect powder or napthalin.

Feed a mixture of sulphur, air-slaked lime, copperas and wood ashes in small boxes. Ticks are absent where this is furnished, and if they reappear under neglect are got rid of again by resuming the medicine.

ŒSTRIDÆ LARVÆ. GAD-FLIES. BOT FLIES.

Hibernate as larva in animals. Characters of fly, of larva, of nympha. Gastricola, larva in alimentary canal. Cavicola, larva in nasal sinuses. Cuticola (hypoderma) larva under skin or in intermuscular tissue. *Œstrus equi:* 6 to 7 lines, body hairy, yellow brown, abdomen reddish, black spots, wing transverse black band, and spots at tip. *Distribution:* America, Europe, Asia, Africa. Ovipositor. Ova glued to long hairs of legs or shoulders of solipeds. Button on closed end glued to hair, open end pendent. Hatched in 24 hours, embryo taken in by tongue or falls on food. Two cephalic hooks fix it to gastric mucosa. Three moultings and stages of growth. Has 12 rings all spined except the two last. Pass out May to October, and in manure or earth form nympha in 24 hours. In 30 days the fly escapes. *Œstrus hæmorrhoidalis:* fly 4 lines, hairy, olive gray with median black band, abdomen first white, then black, at end red, wings spotless. *Distribution:* N. America, Europe. *Ova* black, stuck to long hairs of lip, licked in, or falls in food (manger). *Larva* moults 3 times becoming 6 to 7 lines, greenish, spined except on the two last rings and the middle of the third last. May hibernate in left or right gastric sac, duodenum or pharynx. Hook on to intestines when passing out, and even to skin of anus. Spend 30 days as nympha, then form perfect fly. *Œestrus pecorum:* Fly 5 to 6 lines, black or brownish, with short smoky wings. *Ova* black on shoulder and fore limbs. *Larva* has three moultings, attains 5 or 6 lines, each ring has double row of spines, absent from dorsal centre from the fifth, and entirely absent behind the eighth, except on venter. Spend 30 days as nympha. *Œ. Nasalis:* Fly 4 to 5½ lines, thorax golden, abdomen in bands of white, black, yellow and gray, wings short translucent. *Ova* white, stuck to hairs on nose and lips. *Larva* 5 to 6 lines, rings spined except absent from dorsal centre on eighth and ninth, and from all but the venter on the tenth, hibernates on duodenal mucosa, passes 30 days as nympha. *Œ. Flavipes:* Yellow legged bot fly. *Distribution:* Spain Dalmatia, Africa, Asia Minor, etc. Attacks ass.

The Œstridæ are important in this that their larvæ live in the bodies of animals, through the winter, and emerge in spring and develop through the pupa into the perfect fly. The family has the following general characters:

Head large, and hemispherical; eyes facetted; forehead broad with three eyelets; antennæ short; proboscis very small or absent; body usually hairy; thorax large, prominent; abdomen has six rings, the male having a rounded caudal end, and the female a very extensible ovipositor which curves forward beneath the abdomen. Viviparous or oviparous. The *larva* (grub) has 12 segments, the first two often seeming to coalesce. Between

these are two respiratory pores (stigmata), and two more are found in the last segment. The cephalic segment has two strong hooks, which may disappear with growth. Anus beneath the stigmata of the last ring. The larva undergoes two moultings.

Escaping from its host, the larva burrows in the soil, is transformed into the *nympha* (pupa, chrysalis) and in three to eight weeks (longer in cold weather) emerges as the perfect fly.

The *mature fly* (imago) has the mouth atrophied, and takes no food, but lives upon its own accumulated fat, and devotes its whole energy to the reproduction of its species. They have been divided into three genera: **Gastricola** or **gastrophili,** living in the alimentary canal; **Cavicola** living in the nasal sinuses or caverns; and **Cuticola** or **Hypoderma** living beneath the skin and between the muscles.

GASTRICOLA. BOT-FLIES OF SOLIPEDS AND REINDEER.

1st. **Œstrus Equi.** (*Gastrus Equi. Gastrophilus Equi*) is the largest bot-fly of the horse: length 6 to 7 lines. The body is hairy, yellowish brown with black, white, or yellow spots, the abdomen has a reddish tinge spotted with black. The wing has near its middle a transverse black band, and black spots at its extremity.

These are common in America, and in Europe, Asia and Africa. The female has her abdomen prolonged into an ovipositor, by means of which she lays her eggs from June to October, mainly on the legs of solipeds, during the heated hours of the day. Following the horse she poises opposite the point selected, her ovipositor curved forward beneath the abdomen, darts to the spot deposits her egg and instantly flies back. This is repeated again and again, and the long hairs of the fore-limbs (fore-arm, carpus, and metacarpus) are literally covered with eggs.

The *egg* is dull white, conical, and cemented by the button at its apex to a hair. In 24 hours it hatches out and the embryo, crawling under the hairs, creates an itching which leads the horse to lick or bite the part, and the embryo adhering to the damp tongue is taken in and swallowed. The embryos just about

to escape from the ovum are taken in by the tongue at the same time.

An *embryo* on reaching the stomach at once attaches itself by its buccal hooks, and especially to the left sac. It is then the size of the egg from which it escaped, and of a blood red color, but in the course of the next winter and spring it undergoes three moultings becoming larger on each occasion, and changing to a yellowish brown color.

The *mature larva* (*bot*) as found in the stomach in spring and early summer, measures 7 to 9 lines in length, has a yellowish brown color, and is formed of a series of ten rings, all excepting the two last are furnished with a closely set row of spines directed backward. The ninth ring has a few short spines at the side only. The rings which in the embryo were soft and fleshy are now firm and resistant. Many reach maturity from May to October and pass out with the fæces, showing little disposition to hook themselves on to the intestine in their course. They remain in the manure or burrow in the earth and in 24 hours the envelope becomes hard and horny, the stage of *nympha* having been reached.

In 30 to 40 days, according to the temperature, the *nympha* opens and the perfect fly escapes.

Œstrus Hæmorrhoidalis (GASTRUS HÆMORRHOIDALIS, GASTROPHILUS HÆMORROIDALIS, RED-TAILED BOT FLY) is a small fly, barely 4 lines in length, very hairy ; the thorax olive gray with a black band in the middle ; the abdomen white in front, black in its median part, and orange red at the end ; and its wings spotless. It is common in North America and Europe.

The *ova* are black, the usual color of the lips on the long hairs of which they are deposited, and they are taken in by the animal licking its lips, or they drop into the manger and are devoured with the food.

The *larva* passes through three moultings. When mature it is 6 to 7 lines long, and has a greenish or bluish green color. The spines are arranged in a double row on each ring but on the dorsal aspect they are absent in the middle of the ninth ring, while on the tenth and eleventh there are none. The larvæ pass the winter mostly attached in groups in the left sac of the

stomach, but also in the right sac, and duodenum, and exceptionally in the pharynx.

When mature and passing out through the intestines they often hook themselves for a time to the rectal mucosa where they cause considerable irritation and rubbing of the tail. They also pass through the anus independently of defecation, and hook themselves to the skin round its outer margin, causing rubbing and switching of the tail, and a stiff awkward gait. This habit, with that of laying the eggs on the lips and jaw, and of hooking on to the delicate mucosæ of the pharynx, right gastric sac and duodenum, renders this one of the most injurious of the œstridæ.

When passed the larvæ are rarely found in the manure. The species spend 30 to 40 days as nympha.

Œstrus Pecorum (GASTRUS PECORUM, GASTROPHILUS PECORUM, ŒSTRUS VETERINUS). The **male** fly is 4 to 5 lines in length with a dense clothing of bright yellow hairs and a transverse band of dark hairs on the back. The wings are short and smoky. The **female** is 5 to 6 lines long, black or brownish black with dirty yellow or black hairs, and smoky wings, always shorter than the posterior part of the body.

The **ova** are black, and are deposited like those of the œstrus equi.

The **larvæ** hibernate in the stomach and pass through three moultings. When mature they are 5 to 6 lines in length and of a dark red color. They have a double row of spines on each ring on the dorsal aspect as far back as the fifth, from the sixth to the eighth the spines are wanting in the centre, and behind the eighth they are wanting altogether, though on the ventral aspect they may be present even on the tenth ring.

These pass out with the fæces and spend 30 to 40 days in the condition of *nympha*.

Œstrus Nasalis. (GASTRUS NASALIS ,GASTROPHILUS NASALIS, ŒSTRUS DUODENALIS, ŒSTRUS SALUTARIS). The fly is 4½ to 5½ lines in length, thickly covered on the thorax with black and golden yellow or golden chestnut hairs; on the abdomen they vary, the second ring being usually white, the third black, and the remainder orange or grayish. The wings are very short and translucent, with fine veining.

The *ova* are white, and are usually deposited on the margins of the nose or lips.

The *larva* passes through three moultings, and when mature is 5 to 6 lines in length, yellowish white, and furnished with a row of spines on each ring from the second to the ninth on the dorsal surface, and as far as the tenth on the ventral. There is an unarmed part in the centre of the eighth and ninth rings on the dorsal surface. It spends the winter attached to the mucosa of the commencement of the duodenum, usually in clusters, and is rarely found in the stomach. In passing out it shows no tendency to hook itself to other parts of the intestine or the anus.

It passes 30 to 40 days in the state of *nympha*.

Œstrus Flavipes (GASTRUS FLAVIPES, GASTROPHILUS, FLAVIPES, ŒSTRUS FLORIPES). The *fly* is about 4 lines in length, with a black shield on the thorax and yellow spots on the sides. The abdomen is brownish yellow with a dark line in the middle. The feet are yellow.

Its evolution has not been completely studied, but it attacks asses and mules especially, in Spain, Dalmatia, Africa, Asia Minor, and other warm countries.

ŒSTRUS LARVÆ IN THE PHARYNX.

Œstrus larvæ in pharynx or adjacent part: Symptoms: chronic cough, nasal discharge, sneezing, dyspnœa, difficult deglutition, inhalation bronchitis. *Diagnosis:* anamnesis; obstinate winter sore throat, after pasturage, bots felt by hand, or extracted on sponge, or seen by speculum. *Treatment:* staff with cloth saturated with benzine rotated in pharynx detaches bots; or pick off with finger, spatula or wire loop. *Œ. Trompe. Bots in stomach and intestines. Causes:* exposure of solipeds to fly and eggs; heat of mines; hot climes and summers; cold summers less favorable; *Lesions:* pits in gastric mucosa; alleged perforations; larvæ in pouches in wall of viscus; congestion of mucosa; suppuration; hæmorrhage; indigestion; papilloma; obstructed pylorus or intestine. *Symptoms:* variable, capricious appetite, emaciation, debility, unthrifty coat, late shedding, flabby muscles, early fatigue, stocked limbs; intestinal indigestion, itching or eversion of the rectum, bots in manure, or attached to anus. *Prevention:* stable in summer and fall; cut long hairs from lips, nose, jaws, shoulders and legs, groom well, sponge the skin when enter stable in warm weather, oil when going out, wear cloth under jaws, or net on neck and shoulders, crush bots found in manure. *Treatment:* Benzine, carbolic

acid, gasoline, oil of turpentine, etc., especially in Fall or early Winter. When passing out, aloes with hyoscyamus.

One or more of the œstridæ above named may in the larval condition attach itself to the mucosa of the pharynx, posterior nares, nasal chamber, Eustachian tube, or even the margin of the larynx. Cadeac seeks to incriminate the **Œ. Hæmorrhoidalis** (red tailed bot-fly) and the **Œ. Equi** (common stomach bot-fly), and Clarke and others the **Œ. Nasalis** (golden or chestnut bot-fly).

Symptoms. One or two attached well back in the pharynx may cause only slight irritation with chronic winter cough and nasal discharge. If on or near the posterior nares there is continuous discharge, with frequent and vigorous sneezing. If on or near the margin of the larynx there are violent paroxysmal fits of coughing and dyspnœa. When numerous they may seriously interfere with deglutition and cause roaring. Patients have been asphyxiated and the larvæ were found attached to the epiglottis and hanging into the larynx. In other cases the mucosa has been violently inflamed and the points of attachment of the larvæ excavated into raw sores. In a case reported by Limann the angina was complicated by a fatal broncho-pneumonia from inhalation of food.

Diagnosis is not always easy but the condition may be suspected in obstinate winter sore throat in a horse exposed to the attacks of flies the previous summer, and without any visible cause in faulty stabling, exposure or management. The larvæ may be felt on passing the hand into the pharynx, or a staff with a cloth securely tied to its end may be introduced turned round and withdrawn bringing some bots with it. With a naso-pharyngeal speculum the bots may even be seen.

Treatment: The most promising resort is to introduce a staff with a cloth or sponge firmly tied on its end and saturated with benzine, naphtha, chloroform, olive oil, or with a few drops carbon bisulphide. Russian empirics are said to use a brush on the end of a staff. If within reach the bots may be picked off with the fingers, or a spatula or wire loop may be used.

Œ. Trompe of the pharynx of the reindeer, has the same symptoms and treatment.

GASTRIC AND INTESTINAL BOTS. PATHOGENESIS. LESIONS. SYMPTOMS.

All ages and conditions of solipeds harbor these, the one prerequisite being that the animal shall have been exposed in the open air during the previous summer and autumn months. Horses that live in mines may take them in at any season of the year, the heat of the underground shafts favoring the development of the fly. The larvæ live in the digestive canal for nearly a year, but they seem to become more injurious as they reach full development and near the period of their expulsion. This may be explained by their greater size, and activity, and by the encreasing hardness of the corneous rings and their rows of spines.

In cold latitudes they are as a rule less numerous, and deleterious results are exceptional, or unknown. Thus in England, Bracy Clark was led to believe them not only innocuous but positively beneficial through a supposed stimulation of the secretions of stomach and bowels and improvement of the digestion. A sojourn in Southern or Central Europe or on our American prairies, where they are to be found in hundreds or even a thousand in one animal (Numan), and a consideration of their action on the delicate gastric mucosa of the right sac, or the duodenal mucosa, would have corrected the error. His dose of 25 full grown larvæ given to a horse was really no sufficient test.

In the left sac of the stomach they make small round holes in the mucous membrane from which the epithelium has been removed, so that they are red and vascular, and the margins of which are raised by epithelial hypertrophy. If the larvæ have been detached for some time these pits may contain pus. They rarely extend to the muscular coat.

Circumstantial accounts are given of the actual perforation of the gastric walls by bots. Coleman relates a case in which they had not only perforated the stomach but also the diaphragm and were found in the pleural cavity. Röll vouches for cases of actual perforation seen at Vienna, but allows that the walls of the stomach were probably the seat of preëxisting disease. Numan found four or five holes in the duodenum, with oestrus hæmorrhoidalis in the immediate vicinity and one actually engaged in a

hole. In a foal he found a great thickening of the mucosa on the great curvature with, in its centre, six openings occupied by larvæ. Schliesse found in a paralytic horse a dozen larvæ in a pouch which connected the stomach through the omentum with the vertebræ. Schortmann and Chiari found perforation of the stomach by these larvæ and a resulting peritonitis. Schlippe and Delamotte have respectively found these larvæ in abscesses of the stomach. Hertwig attributes to them a fatal hæmorrhage from its gastric artery. While admitting the probability of such lesions in view of the migrating habits of the hypoderma, there can be no doubt that a number of other alleged instances of this kind have been examples of coincidence rather than of cause and effect. Ulceration and perforation occur from other causes and the larvæ pass through. Abscesses open into both stomach and peritoneum, allowing the passage of the larvæ. Pouches form from abscesses and other causes and are then occupied by the larvæ. The gastric walls are digested while in a state of paralysis or after death, and the larvæ escape. Even ruptures of the stomach from over-distension, strange as it may seem, have in the author's experience been described as cases of perforation by the larvæ. In examining alleged cases this must be kept in mind that perforations by the larvæ must appear as small round holes and in no case as an extended opening or laceration. There must also be extensive peritonitis and especially around the points to which the larvæ have hooked themselves.

But independently of perforations, the buccal hooks and the spines of the larvæ will sometimes irritate to the extent of causing congestion, indigestion, inflammation, suppuration or even hæmorrhage from the mucosa, which may prove dangerous or fatal. This is above all the case when the bots are attached to the right sac of the stomach or the duodenum. In the left sac papilloma is frequently found in connection with the irritation caused by them. In and near the pylorus inflammation and thickening of the mucosa has blocked that opening and induced dangerous indigestion.

Animals often show in winter a variable, capricious appetite, emaciation in spite of the best feeding and care, unthrifty coat, late in being shed, frequently recurring colics, a soft flabbiness

of the muscular system, a lack of energy, a tendency to swelling of the legs and general ill health, and this persists until the period comes for the discharge of the bots, when a prompt recovery takes place. This is especially true of horses that have been at pasture the previous summer and autumn, while those kept indoors in that season in the main escape.

When detached in large numbers at a time the œstrus larvæ may actually block the pylorus or some portion of the small intestine and cause dangerous indigestions. This I have repeatedly seen in animals which have died of acute gastric indigestion.

Again the larvæ of œstrus hæmorrhoidalis by hooking on to the intestinal mucosa and especially that of the rectum and anus, cause indigestions or severe itching and straining and according to Hertwig eversion of the rectum.

Symptoms. The symptoms caused by the presence of the larvæ of the œstrus in stomach or duodenum are varied and not at all pathognomonic. Recurring colics, poor condition, swelling of the legs, or under the abdomen, cough, contraction of the masseter and turning up of the upper lip, occurring frequently in the course of winter, spring or early summer, may create a more or less well founded suspicion. The ordinary signs are well illustrated by the remarks of the late Joseph Gamgee: "I could not rely on one of the Italian horses taken up from grass in the end of summer, in less than nine months or a year, such condition I mean as would fit them for any severe work." Of Italian horses from the same breeders, but which had spent the previous spring and summer indoors, he says, "they invariably thrived so rapidly, that in two months they were in beautiful condition as riding horses. * * * They had lost the bots just before I obtained them." The colics and indigestions resulting from the irritation of the pylorus or intestinal mucosa in their passage outward, do not differ from ordinary attacks of this kind, resulting from other causes, but may often be diagnosed by the presence of bots in the manure.

When the larvæ are attached to the rectum or anus there is the stiff, straddling gait, the switching spasmodic depression and rubbing of the tail, and sometimes the presence of the larva attached to the anal ring.

Treatment. *Prevention* should be aimed at. Stable the animals in summer and fall; clip off the long hairs from lips, nose, jaws, shoulders and legs, so that the flies may fail to find the customary supports for their eggs; groom thoroughly so as to detach the eggs by brush or damp sponge before they have had time to hatch out their embryo; smear frequently with oil the parts where the eggs are usually deposited to prevent their cement from adhering; cover with a cloth under the jaws to keep the flies at a distance; crush any larvæ that may be seen in or beneath the balls of manure in summer or autumn.

Therapeutic treatment is unsatisfactory owing to the extraordinary vitality of the larvæ. They will live almost indefinitely in a saturated solution of common salt, in alcohol, in castor oil, in olive oil, in a strong solution of aloes, thymol, sodic sulphate, arsenic or asafœtida, in extract of nux vomica, in solutions of morphia, narcotine, strychnia, cupric sulphate or tobacco. Lime water and empyreumatic oils failed to kill them. Numan tried in vain to kill them with irrespirable gases, hydrosulphuric, hydrochloric, and prussic acids, and caustic ammonia. Voigtlander found that they survived fifteen hours in a concentrated solution of potash. The pulped roots of bryony, acorns and sulphate of mercury have been strongly recommended, but failed in general application.

Magné strongly recommends oil of turpentine as killing the bots, even when largely diluted in milk. Santy says they are promptly killed by pure bile, but it is useless if diluted. Gayot recommends ether and empyreumatic oils in a mucilaginous solution. Rey recommends benzine as the best resort in one or two ounce doses. More recently carbolic acid in half ounce doses largely diluted has been found effective. Bisulphide of carbon has also proved useful. It may be given in doses of 1 drachm in alcohol, or in bolus with aloes.

All active agents are likely to be more effective in the young soft bot in fall. Porcher says the berries of the azedarach planted around stables are used in the South to protect horses against bots.

Apart from medicinal agents a nourishing diet which will sustain the strength of the horse and furnish plenty of food for the parasite is of great importance. The well fed horse can best stand the constant drain, and the well fed parasite is lazy, in-

active and comparatively non-irritating. It is doubtless owing to this soothing effect that potato juice has gained a reputation for killing bots. Horses fed on potatoes, however, harbor the live bots as before.

Colics resulting from this parasite should be treated by antispasmodics, and a liberal use of demulcents such as flax seed tea, boiled flax seed, potato juice, slippery elm, white of egg, gluten, decoction of mallow, etc.

During summer when the parasite is passing out through the intestines, the elimination may be hastened and the irritation cut short by a dose of aloes and hyoscyamus or belladonna. The number passed after such medication is often astonishing and nearly all the alleged remedies have acquired their reputation from having been used at this stage. They only hasten what is already taking place and are utterly useless at any other season.

When a horse becomes sluggish and awkward in driving, in warm weather, the tail should be lifted and any bot attached to the anus removed. Should the rubbing of the tail and stiff gait continue the rectum as well may be explored for larvæ.

CUTICOLA. HYPODERMÆ. GAD FLIES HIBERNATING UNDER THE SKIN.

Characters of hypoderma. *H. Lineata:* black with longitudinal gray bands on back, 12 to 13 mm. long. Larva with spines on 10th ring. *Distribution.* U. S., England, Norway, Germany, Italy and Southern Russia. Ova laid on skin, taken in by tongue, larvæ migrate from gullet etc. to beneath skin of back. Warbles. Wandering larvæ in other tissues from autumn to February. Three stages. Larva escapes in June to August, forms pupa in soil, and in 30 to 45 days the mature fly. *H. Bovis:* black, with longitudinal black shining bands, abdomen with three zones—1st. white or yellow, 2d. black, 3d. orange; 13 to 15 mm. long, legs black and yellow, wings brown. Larva shorter, no spines on 10th ring. Development as in *lineata*. *H. Tarandi* of reindeer black band across thorax. Larva larger than *bovis*. Pathogenesis. *H. Bonassi* of bison, like *lineata*. *Dermatobia Noxiales*, of man, dog and ox. Tropical and subtropical America; grayish, steel-blue nearly hairless, wings brown, face yellow; 14 to 17 mm. long. Larva 1 inch, spines on first five rings. Pathogenesis. *D. Cuniculi* of rodents in middle and Gulf States. *Gadding of Cattle: Symptoms:* tuft of erect hair on back in winter or early spring, later central hole showing dark head of larva which forms a nodular elevation,

suppuration, emaciation, unthrift, hide depreciation. *Treatment:* extract the grubs in winter or spring, and crush them: inject the holes with benzine; stable on paved floor till 10 a. m. from spring to fall; smear backs with myiacides.

The general characters of this genus are: Head broader than thorax; antennæ very short and deeply sunken in pits; proboscis very rudimentary; membranous; palpi wanting; body hairy; thorax round; ovipositor in four segments telescoping each other, the last with three horny appendages between which the egg passes.

Hypoderma Lineata. Striped Hypoderma is proved by Curtice to be the common gad fly of cattle in the United States. It is 12 to 13 mm. long, black, very hairy, and characterized by longitudinal gray bands on the upper surface of the thorax. Its larva is to be distinguished from that of the H. Bovis of Europe by the presence of spines on its tenth ring. It has been found in England, Norway, Germany, Italy and Southern Russia as well as in the United States.

Curtice successfully contests the formerly received opinion that the egg or larva was deposited on the skin and burrowed through it. In autumn and particularly in November he found the young grubs in the walls of the gullet and among the surrounding muscles from which he concludes that the embryos are licked from the prurient skin, and, being swallowed, bore their way through the softer tissues of the œsophagus. Those that succeed in making their way toward the skin form the *warbles* or *grubs* and those that fail in this quest perish. Henrichsen has found grubs in the spinal canal, Baur in the subcutaneous muscles, and Curtice one near the spleen. These wandering grubs have only been found in autumn and up to the beginning of February, while later, they are found in little nodules under the skin, over which the hair stands erect ("lick"), later still a hole is formed in the centre of each nodule, at the bottom of which the grub can be felt or seen.

Three stages corresponding to the two moultings are recognized and have been studied and figured by Miss Ormerod. In the *first stage*, corresponding to the pericœsophagean and early subcutaneous life, the larva is about 10 to 15 mm. long. The *second stage*

corresponds to the month of May, and lasts about thirty days, with the larva club-shaped and 13 mm. long. Spines are now present on the 1st, 2d, 3d, 9th and last rings. In the *third stage* the larva is pear-shaped, with more prominent spines, and corrugated skin, and a grayish yellow, and finally a yellowish brown tint.

The orifice enlarges, and the mature larva bores its way out, in June, July or August, passes into the soil or under some projecting object, is transformed into a pupa, and in a month or six weeks develops into the mature fly.

Hypoderma Bovis. - Ox-Gad-Fly of Europe. This is 13 to 15 mm. long; black, very hairy, and marked by longitudinal bands of shining black on the thorax; abdomen black with a front zone of white or yellow hairs, followed by one of black and finally of reddish orange; proximal half of legs black, distal half yellow; wings brownish; face gray with white or yellow hairs. *Larva* shorter and thicker than *lineata*, and devoid of spines on the 10th ring. Development and habits the same.

The identity of the larvæ found under the skin of horse and ass is uncertain. A hypoderma, common in field mice where cattle suffer, has been identified as hypoderma bovis by G. Korff.

Hypoderma Tarandi. Attacks the reindeer. Female 16 mm. long; black, very hairy; broad black band across the thorax, which has yellow hairs; abdomen, anterior zone with yellow hairs, posterior with dun, legs black; distally grayish yellow. Larva like that of H. Bovis but larger.

They attack the reindeer in July driving them from pasture and up to the glaciers, or into smudge from burning grass. Are said to cause emaciation or even to destroy the young.

Hypoderma Bonassi found as larva in the American bison strongly resembles the H. Lineata, and the same remark applies to others given in our list and not fully identified.

Dermatobia Noxialis. The larvæ of this is found under the skin of man, dog and ox in Mexico, West Indies and Central and South America. It is grayish and steel blue, and almost hairless; wings pale brown; face yellow; 14 to 17 mm. long. Larva 1 inch long; with spines and hooklets on the first five rings, and two strong hooks at the mouth. Dull white color.

This produces great irritation and emaciation and not infrequently death (Boussingault).

Dermatobia Cuniculi. This is found in the Middle and Southern States, the giant larva hibernating under the skin of the rabbit, hare, gopher and opossum. The larva in field mice (Korff) may be the dermatobia cuniculi. The *Cordylobia murium* is very fatal to rats in E. Africa. The larvæ pass from the ground into the skin. Similarly on the Guinea Coast the *Gordylobia Anthropophaga* (Cayor fly) attacks man, dog and other animals.

Gadding of Cattle. From the time of Virgil "*gadding*" has been attributed to the attacks of the hypoderma. So sensitive are cattle to the fly that, in districts where it prevails, it is only necessary to enter the field and make a persistent buzzing sound to start the cattle, with heads and tails in the air, at full gallop for the nearest water. As the fly can neither bite nor sting it has been denied that this particular fly is the cause of dread, and yet the common experience with the reindeer, the sheep and the horse, gives support to Virgil's opinion.

Symptoms. The first symptom of the hypoderma is the erection of the hair ("lick") over a small tumor on the back or elsewhere. At this date (in winter or early spring) no opening can be found in the tumor, but later a round hole is formed in the center, which gradually enlarges and through this the grub finally makes its exit. The tumors known as *warbles*, *wormils* or *wurnils*, may vary in size from a large acorn to a walnut. They are at first hot and tender or itchy, but after the orifice has been formed, in the late winter and spring they usually show little irritation. Yet each is the seat of suppuration which serves to support the imprisoned larva, and when numerous they cause emaciation and unthriftiness. The loss of $5 per head is claimed in England, and among dairy cows as much as $15 per head. The loss on hides is also considerable, these being depreciated in ratio with the number of holes, or up to half their value in bad cases. The hides from the countries that are hot and damp, and from those with much brush and foliage are usually the worst. Those from North Africa, India and China, are greatly deteriorated, and those from Australia, South Africa, and South and North America much less so.

Treatment. The most important step is to go over all the cattle in winter or early spring, squeezing out the grubs and crushing them so that the stock of flies for the comming summer may be cut off. If this practice could be made universal a whole country could be speedily cleared of the pest, and there would be nothing unreasonable in making it obligatory on all stock-owners. They may be killed in their sac by the insertion of a lancet, or a red hot wire, or by injecting benzine, carbolic acid, oil of turpentine or oil of tar, but the decomposing larva remains as a source of irritation and infection.

In some parts of Europe the cattle are held indoors until ten o'clock every morning, from April to August, so that the larvæ (which habitually escape before this hour) may fall on the paved floor and perish for lack of a shelter in which to pass the stage of pupa.

In England the flies are driven off by agents smeared on the backs of the cattle. Crude pine tar smeared on the shoulders is very effective, requiring only two applications in a season. Equal parts of tar and oil mixed, is equally effectual but less permanent. Sulphur ointment ; sulphur, oil of tar and oil ; naphthalin ; creolin, and other myiacides will act well, but for a shorter time.

These last named agents would be specially applicable to horse and sheep where tar would be hurtful to wool or harness.

CAVICOLA (cavum cavity, colere to inhabit). CEPHALEMYIA (cephale head, myia fly). ŒSTRIDÆ HIBERNATING IN NASAL SINUSES.

Œ. Ovis : Like house fly : 10 to 12 mm. long ; yellow gray ; hairy ; abdomen variegated. *Distribution :* Europe, Asia, Africa, America. Viviparous. Flies May to October ; in warm folds all winter ; lodges the embryo on margin of nostrils ; latter enters nose ; turbinated bones, and sinuses ; hibernates, escapes in 10 months, forms pupa in ground and in 3 to 8 weeks the perfect fly. Larva : 2 mm., grows to 20 mm. ; with 11 rings, smooth dorsally, spined ventrally ; 2 buccal hooks ; 2 moultings. *Lesions :* Larva, and exuvia, mucopurulent discharge, congestion of pituita and even cerebral meninges. *Symptoms :* Fly darts on nose leaving the grub ; sheep starts, snorts, shakes head, stamps, rushes off with nose to the ground, seeks a rut, road, furrow, or sheep collect in mass, heads in and nose to ground. Attacks in heat of day. Clear, purulent or bloody discharge from

the nose, sneezing, rubbing face, shaking head, swollen nostrils or intermaxillary space, snuffling, hurried breathing, diarrhœa, congested, watery eyes, rolling eyes, dilated insensible pupils, dullness, prostration, inappetance, emaciation, grinding teeth, salivation, high stepping, staggering, death. A few larva often harmless; many deadly. Aggravated by glare of sun, debility, septic infection, close confinement. *Diagnosis:* From cœnurus, in attacking all ages, in winter mainly, in sneezing, nasal discharge and expulsion of grubs. *Prevention:* Keep from coarse tufty pastures, brush; smear nose with myiacide, tar, from auger holes, holding salt, grow broom, face cover with tar or asafœtida, plow up furrow in field, benzine, sprinkle folds with tar, naphthalin or lime water. Keep clean. *Treatment:* Sternutatories in first few weeks—quick lime, hellebore, snuff, naphthalin, benzine injections. Tobacco smoke, burning tar, fumes. Surgical: remove horns or trephine sinuses, inject benzine, water, and again benzine. Close wound; apply tar. *Œ. Maculata* of camel, dromedary and buffalo. *Œ. Trompe* of reindeer. *Œ. Variolosus. Œ. Purpureus.*

Œstrus (Cephalemyia) Ovis. Sheep Gadfly. This is small, about the size of a house fly (10 to 12 mm.); yellowish gray, with very short, fine hairs, each set on a small tubercle; abdomen in five rings, variegated color; legs brown; wings diaphanous with three dark spots at their base. Eyes purplish brown; three eyelets on top of the head; no mouth; under side of head white.

This fly attacks sheep and goats in Europe, Asia, Africa, Australia, the Canary Islands, and North and South America and is very destructive. It is viviparous, and flies from June to October, and, in warm folds where early lambs are raised, for the whole winter, following the sheep and depositing the grub on the margin of the nostril. By the aid of its hooks the embryo attaches itself and works its way up into the nose. It hibernates in the turbinated bones, but especially in the frontal and maxillary sinuses, remaining there for about ten months, and having attained larval maturity, it passes out into the nose and is expelled by sneezing. It bores its way one or two inches into the ground, contracts to about half its former size, becomes a pupa in about two days, and in from three to eight weeks more emerges as a mature fly.

Œ. Ovis attacks man and dog in Algeria (Kabyla hills,) of the Atlas range in warm days with a temperature of 86° F., in districts where sheep are few and men numerous. Sufferers are mainly shepherds and dogs that feed on fresh ewemilk cheese,

and thus carry the ovine odor. The larvæ create intense inflammation where they are lodged—eye, lips, ear, nose or throat. The fly is known in different localities as Thim'ni: La Calle: Ledgha: Deban-el-ghenem (sheep fly): Deban-el-ras (headfly): Deban-el-doud: Tenid-el-Haad. (Sergent. Ann. de l'Inst. Pasteur, 1907.)

When deposited on the skin the *larva* is about 2 mm. long, and it gradually grows to 20 mm. It has eleven rings, smooth on the dorsal aspect and covered with spines on the ventral, and is furnished with two strong buccal hooks. After the first moulting (usually in March), it attains a length of 6 mm., and changes from a white to a yellowish shade. After the second moulting it changes to a deep brown, the integument becoming hard and resistant.

Lesions. These consist, first in the presence of the larvæ (1 to 10 or more), mostly in the frontal sinuses, and in horned sheep in the hollow bony supports of the horns; in mucopurulent matter; in the debris of the cast off integuments and dead larvæ; in caseous collections; and finally in congestion, redness, thickening and even ulceration of the mucosa. The congestion may have extended through the cribriform plates to affect the cerebral meninges.

Symptoms when attacked by the fly. Sluggish at other times, the female fly when about to deposit its young moves with great rapidity and darts upon the nose so as to be almost invisible. The sheep, warned by the hum, or even by the sight or touch of the fly, starts suddenly, shakes the head, snorts perhaps, stamps its foot and rushes off with its nose toward the ground, often turning at intervals and starting in a new direction as if the fly had headed it off, or as if a fresh one had come out of the grass. If available they find a rut, or dusty road where by snorting they raise a cloud of dust that serves to protect them. In other cases they push the nose under the bodies of their fellows, or a group collects with noses turned inward and toward the ground so that the fly cannot approach. Often they crowd together under trees, fences or buildings or by an available rock or bank to escape their enemy. The fly is only active in the heat of the day. At night and morning the sheep have a respite. In a warm sunny corner or inside a window they may fly even in winter.

Advanced Symptoms. These are referable to the irritation of the mucosa lining the turbinated bones or sinuses. A discharge from the nose appears, unilateral or bilateral, at first clear and later purulent or even bloody with frequent sneezing and snorting, and at times the expulsion of a grub. The sheep rubs the face or nose on adjacent objects or raises a fore foot over it as if to rub off a source of irritation. The head may be suddenly flexed, or extended, turned to one side or shaken spasmodically. Swelling of the throat, or nostrils, or of the intermaxillary space is seen in bad cases, with oppressed breathing and diarrhœa. In these cases too, there is evidence of visual and nervous disorder. The conjunctiva is always congested and watery, but the eyes may also roll, or the pupils may fail to give the natural response to light. The subject becomes dull, and prostrate, carrying the head low and often turned to one side, appetite and rumination are imperfect or suspended, and there is loss of flesh. There may be grinding of the teeth and drivelling of saliva. When the patient walks it may lift the feet high as if travelling in water, or it may move unsteadily or stagger, and even fall. These symptoms usually herald an early death, from the third to the eighth day after their onset.

But in the great majority of cases, with a few larvæ only in the sinuses, the disease is not fatal, and no symptoms are noticed beyond muco-purulent nasal discharge, perhaps bloody, and some loss of condition.

But even these mild cases may become redoubtable in connection with the glare of the sun from a stretch of snow, or water, or in debilitated or asthenic subjects that have been sick from other causes, or from close confinement indoors in winter.

Diagnosis from *coenurus cerebralis* is made by the facts that the latter rarely occurs except in lambs or yearlings, that it is not associated with nasal discharge nor sneezing, that it shows no tendency to rubbing of the face, and that no grubs are discharged from the nose. The appearance of the symptoms in spring or early summer points directly to *grub in the head.*

Prevention. Keep sheep away from infested, coarse, shrubby pastures from June to October. If this is impossible apply upon the nose articles which repel the fly. Place a log in the pasture bored full of augur holes 2½ inches in diameter and 4 or 5 inches

deep, and feed the salt from these holes, the margins and walls of which are kept smeared with tar, or better, a mixture of tar, napthalin and lard. In this way the sheep are daily dressed without trouble, and the flies are kept at a distance. If all could be compulsorily dealt with in this way the pest could soon be eradicated from a country. When goats are present they must partake of the treatment. Some flockmasters believe that the English broom (Cytisus Scoparius) in the pastures protects the sheep against the fly. Crude tar, or a mixture of tar and oil, may be smeared on the nose with a brush every few days from June to October. Some use a canvas face cover smeared with tar and lard, or asafœtida and lard during the same months. Others plow up a furrow at intervals in the pasture in which the sheep may poke its nose when attacked. In a small flock many of the young larvæ may be killed by a weekly or more frequent treatment with benzine, a teaspoonful in each nasal chamber, the sheep having been turned upon its side to be treated, and the head held nearly level. The soft young grub is more easily destroyed than the older case-hardened ones. Sheep folds, in summer, should be frequently sprinkled with tar water, napthalin or lime, and kept clean. All grubs seen on the ground should be crushed. Heads of slaughtered sheep, and those dying of "grub in the head" or other disease, should be boiled.

Medicinal Treatment. Sternutatories have been used for a length of time with the view of causing the expulsion of the larva by sneezing. They can only be effective in the first few weeks and for the young grubs that have not yet entered the sinuses. Quicklime, powdered white hellebore, snuff and napthalin may be tried, especially the two latter. A pinch may be placed in each nostril several times a day. Most liquid injections are of little more value. Tobacco water, oil of turpentine, and olive oil or glycerine in equal parts, oil of tar and other agents have been employed, being injected with a syringe and long nozzle. In the writer's hands benzine has proved better than anything else. The sheep having been placed on its side with the nose slightly raised, a teaspoonful is poured into the nostril on the lower side and the nostril closed for thirty seconds. It is then turned on the other side and the other nostril similarly treated. It may be repeated daily or less frequently until the grubs are destroyed. This

agent, so deadly to the parasite and harmless to the sheep, tends to enter the sinuses through gravitation and its extreme volatility and diffusibility, and can only escape slowly.

Tobacco smoke has also been tried but is not to be recommended. Fumes of burning tar and sulphur have been highly commended.

Surgical Treatment. This consists in boring into the frontal sinus, washing this out with tepid saline water that has been boiled and then injecting some one of the agents advised in case of the nose, notably benzine. In horned sheep the operation is exceedingly simple, the opening being made close to the root of the horn in the frontal crest which extends from horn to horn. An incision may be made in the skin and the bone laid bare so that the trephine used in cœnurus may be employed. In its absence I have often used a good sized gimlet, directing it from behind forward, or from before backward across the crest so that if it should make a sudden plunge when it has perforated the outer plate it cannot possibly pass into, or through, the inner. A most effective way of reaching the sinus is to cut off the horn at its root. In polled sheep the procedure is more delicate and difficult. A transverse line is drawn across the forehead from the middle of the one superciliary arch to that of the other; a second line is drawn down the centre of the forehead and face; the incisions are made in the upper angles formed by these lines, and where the bone is most prominently rounded. In perforating the bone one should use the guarded trephine as in cœnurus, or, if a gimlet is resorted to, it should be carefully guarded by the fore finger, so that it may not plunge through the inner bony plate when it has fully perforated the outer. One or both sides should be operated on according as the discharge is from one or both nostrils. In washing out the sinuses it is well to first introduce a teaspoonful of benzine to loosen or stupefy the larvæ, and then a large quantity of tepid salt water to wash these out through the nose. Finally a little benzine may be injected and left in the sinus to distroy any larva that may have been left. This done a stitch may be placed in the wound, and a covering of tar or crude turpentine applied. Some add a canvas or leather face cover.

For very large flocks Railliet, Neumann and Curtice advise the slaughter of the worst cases, and the abandoning of the rest.

But for large as for small flocks the rational treatment is prevention, and the extinction of the fly in the locality.

Œstrus (Cephalemyia) Maculata: Spotted Œ., hibernates as larva in the nasal sinuses and pharynx of camel, dromedary and buffalo, producing irritation and even death as in the sheep. It is twice the size of the bot of the horse.

Œstrus (Cephalemyia) Trompe: Trumpet Œ., hibernates in the pharynx and nasal sinuses of the reindeer, proving fatal in many cases.

Nasal and pharyngeal larvæ have been found in deer, goats, and other solidungula.

These must be dealt with on the same principle as the œstrus of the sheep, and the pharyngeal œstrus of the horse.

Œ. Variolosus inhabits S. Africa, and **Œ. Purpureus** Central Europe and the Caucasus, but their larvæ are unknown.

PULEX. FLEA.

Compressed from side to side; wingless; piercing sucking rostrum; great jumping agility; thorax with three rings, abdomen nine; hairy; strong legs with two claws each. Oviparous: ovum in 6 to 12 days produces hairy worm-like larva with 12 rings and bispiked tail; in 11 days this spins a cocoon, it moults, becomes a pupa and in 10 to 20 days a flea. Live in haunts of animals, hide in clothing, furniture, earth, sand, beds, nests, etc.; prefer given species of host but do not attack them alone. Facultative parasite. *Dog-flea:* Fine tooth-like, black spines (14 to 18) beneath head and prothorax, each side; harbors larva of tænia canina. *Flea of Man:* No teeth on head nor prothorax. *Rabbit-flea:* Angular front of head; five or six teeth on head and prothorax, each side. *Bird-flea:* 12 to 13 teeth each side of prothorax, none on head. *Prevention:* Boil blankets, rugs and clothing; scald kennels, dove-cots, poultry-houses, nests, etc.; litter with fresh walnut leaves or pine shavings; insect powder; stavesacre; wormwood; creolin; lysol; cresyle; carbolic acid; oil of tar; sticky fly-papers. Same agents on animal, also laurel oil and snuff, potassium sulphide. For yards, runs, etc., quicklime, chloride of lime, tar water. Beat rugs and furniture. Sea-weed attracts and may then be burned. *Chigoe:* In tropical America and Africa. Lives in green vegetation, sand, etc.; burrows in skin of man, and tame and wild mammals and birds; lays eggs and hatches young in galleries, causing irritation, ulceration, gangrene, and loss of parts. *Burrowing-flea of hen:* In Ceylon. *Treatment:* Rub feet or legs with tobacco, carapa or arnotto; extract flea without escape of eggs; kill with hot wire, lunar caustic, tincture of iodine, benzine, phenol. ***Rhynchopsylla pulex***, a

flea with long hooks on jaws, and, in female, long abdomen, on parrot. *Helminthopsylla: Alakurt:* With worm-like abdomen on cattle, horses, sheep and camels in Turkestan.

Fleas are usually considered as a sub-order of the diptera, but they are permanently wingless, have their bodies flattened from side to side, a piercing and sucking proboscis, and great jumping powers.

The head is small, round or angular, with two serrated mandibles, between which is a rigid perforated stylet and sucker, and a lower lip terminating in two palpi. Two eyelets are placed in front of the antennæ. The thorax has three rings and the abdomen nine, the whole extremely flattened from side to side, and covered with hairs. The legs thick and strong, the last segment of each terminated by two claws, oviparous.

The egg in six to twelve days produces a vermiform, hairy larva of twelve rings and head. The larva has mandibles, antennæ, and at its tail two spikes which like the hairs aid in progression. About the eleventh day it spins a small silky cocoon in which it moults, becomes a pupa and develops into a mature flea in 10 to 20 days. The ova, larvæ, and pupa are found in carpets, rugs, furniture, beds, kennels, barns, poultry houses, etc., as well as in the open air where the victims lie, and in the nests of wild animals, fox holes, etc. Fleas are very predaceous and are not over particular about the species of their victims, yet they show a preference for given species and genera. The dog, cat, rabbit, rat, mouse, pigeon and chicken especially harbor the flea in their hair, fur, or feathers. The parasite may even pass through all its transformations on the body of the one animal when the skin is covered with dirt or diseased products. Parasitism is not obligatory as they will live long in empty buildings, fox holes, etc. Fleas must be dreaded as a common means of carrying infectious diseases of different kinds. The rat flea of Russia (Typhopsylla musculi) does not bite man, and does not convey plague, but the common flea of dog and cat, which bites both man and rat does convey it. Baker identified 47 species of fleas in America.

Pulex (Ceratopsyllus) Serraticeps: Dog Flea, is characterized by the presence, on the lower margin of the head and the posterior margin of the prothorax on each side, of 14 to 18 black toothlike spines. This is the most common flea of dog, cat and

man. It is interesting as a common host of the larva of the tænia canina of the dog.

Pulex Irritans. Flea of Man, is distinguished by its darker brown color, and by the absence of the rows of teeth along the lower border of head and prothorax. Common in dwellings in Europe, this is said by Comstock to be rare in the United States.

Pulex Goniocephalus: Flea of Rabbit and Hare, is characterized by the angular front of the head, and by the presence of 5 or 6 teeth on each side on the lower border of head and prothorax.

Pulex Avium: Bird Flea. This is characterized by a round head, destitute of teeth on its lower border, but having 12 to 13 on each side of the lower border of the prothorax. This attacks pigeons and small birds especially, and is less troublesome for poultry.

Destruction and Prevention. Railliet recommends to boil a horse blanket or other textile fabric used in the infected kennel, or building, also the deluging of kennels, poultry houses and dove cots with boiling water and then littering them with fresh walnut leaves. Insect powder, stavesacre, or wormwood will serve a similar purpose, or solutions of creolin, lysol, cresol, cresyl, carbolic acid or oil of tar. Fresh pine shavings are useful but soon lose their effect. Sticky fly papers on the floor turn to account the jumping habits of the flea. As an application to the dog, cat or bird, Persian insect powder dusted freely between the hairs or feathers, or moistened with alcohol and rubbed in upon the skin does well. Stavesacre, wormwood, parsley or creolin powder may be substituted. Laurel oil with a little snuff added may be rubbed well in on the skin and a good soapy bath given twelve hours later. Solutions of potassium sulphide, creolin or lysol (3:100) may be similarly applied. Measures must also be taken for the destruction of the larvæ. Kennels, and other buildings must be thoroughly cleaned; infested rugs, carpets, litter, nests, etc., must be burned, boiled, or freely sprinkled with borax, lysol, creolin or tar water. Cracks may be filled with a solution of mercuric chloride (1:500). The yards and places of resort of the infested animals, must be cleaned of decomposing organic matter and freely and repeatedly sprinkled with quicklime, chloride of lime, creolin or tar water. In houses rugs,

carpets, and upholstered furniture must be frequently shaken or beaten. Railliet advises a litter of seaweed or moss in which the fleas seek shelter and can then be burned. Apply strong ammonia or sodium bicarbonate solution to the bites.

Pulex Penetrans: Sarcopsylla P.: Chigoe: Sand Flea: Burrowing Flea. This is found in tropical America (Mexico, W. Indies, Central and South America), and Africa. It lives in woods, foliage and sand, and attacks man, pig, dog, sheep, goat, ox, horse, ass, mule, cat, birds and many wild animals. The fecundated female alone penetrates under the epidermis and produces its eggs, often over 100. This causes much inflammation, ulceration and even gangrene, which implicate the tendons, muscles, bones and joints. In man toes may be lost in neglected cases, and in animals, toes, feet and even limbs.

This is about half the size of the dog flea (1 mm.), and is further distinguished by its angular and serrated forehead. The color is reddish brown.

Sarcopsylla Gallinacea found in Ceylon by Mosely and Green, is distinguished from the last, by its short body about as broad as long, and by several prominent angles on the head. It attacks the eyelids and neck of chickens and causes great irritation.

Florida Flea. W. A. Munsell tells of a small black flea in Florida, which burrows its head only in the skin, where it aggregates in dense clusters creating great irritation. It detaches itself when thickly smeared with salted lard, which doubtless blocks its breathing pores.

Treatment of Chigoe. To protect against the parasite the negroes and Indians rub the feet and hands with infusions of tobacco or oil of carapa, or again arnotto or almond oil. When the Chigoe has burrowed, extraction with a needle is indicated, great care being taken to avoid rupture of the abdomen and the escape of eggs into the sore. In case of such an accident they may be burned with a hot wire, a stick of lunar caustic, or tincture of iodine. Mercurial ointment, benzine, carbolic acid or lysol may be used.

Rhynchopsylla Pulex. A flea with hooked, recurved mandibles, and, in the female, a long, wormlike, articulated abdomen, has been found on the parrot.

Helminthopsylla Alakurt, another flea with vermiform or articulated abdomen, in the female, is particolored, black and white, and lives on cattle, horses, sheep and camels in Turkestan. It is 6 mm. long. It appears to hibernate on animals, attacking them late in autumn and becoming more prevalent as cold encreases.

HETEROPTERA: BUGS PROPER.

Bugs of pigeon nest: Flat body, long sucking trunk, margin of body more incurved than bed-bug. Cause debility; drive pigeons or hens from their nests. Live months without food. *B. of Swallow's nest:* Infest dwellings and poultry houses. *Bed-bug:* More deeply notched on prothorax than pigeon bug. Ova in summer in cracks in wood, etc.; young moult 4 times in 11 months. Attack at night. Live two years without food. *Destruction:* Insect powder; mercuric chloride; leafy plants attract and may then be burned; sulphurous acid; carbon bisulphide. Other bugs.

Acanthia Columbarum: Bug of Pigeon Nest. This is a parasite closely resembling the bed bug, but smaller, more rounded, with shorter antennæ, and with the lateral borders of the abdomen more incurved. The flat body, the long sucking proboscis, and the claws on the distal ends of the limbs, are as in other bugs. The greatest breadth is at the middle of the body. They have the same offensive odor when crushed.

These may abound in foul dove cots, hiding in the cracks, beneath the manure, and in the litter of the nests and attacking the birds more particularly at night or when hatching. They are also found in hen coops and poultry houses, especially such as adjoin dovecots, pestering the fowls so as to check laying and growth, and driving the sitting hens to abandon their nests. In such cases the eggs are marked with black spots caused by the excrements of the bugs. These bugs are very tenacious of life. Railliet claims that he has kept them alive for months in an empty glass bottle, where they could get no nourishment.

A. Hirundinis. Bug of the Swallow's Nest is not uncommon, and would appear to be the means of infesting dwellings and poultry houses.

A. Lectularia: Cimex L.: The Bed Bug. This closely resembles the A. Columbarum, but it is more deeply notched on

the front of the prothorax, has its greatest breadth back of the middle, and the abdomen a little less round.

The ova are laid in March, May, July and September in joints and cracks of wooden beds, floors or walls, under wall paper, in folds, etc., of matresses, and the young undergo four moultings in the course of about eleven months.

The mature bug evades daylight, but comes out in the darkness and attacks human beings showing a preference for some and a dislike for others. They make painful bites sucking the blood, and giving rise to great trouble and suffering. They have been the intermediate bearers of bacillus tuberculosis from man to man and they may well carry other infections. Tenacious of life they have been kept two years alive in an empty bottle. (Audouin).

Destruction of Bugs. To destroy the bugs Persian insect powder may be blown freely into all the cracks and joints about the bed, in walls, floor, wall paper, etc., and may be freely dusted in the nests and about the building in the case of dove cots and poultry houses, also under the feathers of the hens. Mercuric chloride in powder or solution is still more effective but must be used with greater caution on account of its toxic qualities. It should be introduced freely into all recesses, the possible hiding places of the parasite, and left until the insect has finally disappeared. In aviaries the nests and roosts, above all, should be thoroughly saturated. Cleanliness is an essential condition of success as the caddice and excretions will otherwise afford shelter for the parasite. Yet if the places where the bug reaches its victim are kept saturated, the final destruction is certain, for all gravitate toward these points. Railliet says that narrow leaved cress, or haricot leaves laid in the beds, nests, etc., soon become covered with the bugs, which may then be burned, and the same process repeated until the last have disappeared. Wild thyme, laid between clothes, quickly destroys bugs, with closed doors all are gone in 48 hours. Others advocate thorough fumigation with sulphur. Bisulphide of carbon too may be sprayed over the infected places and things, care being taken to exclude all heat, or lights, as it forms with the air an explosive mixture. Hydrocyanic acid gas set free in a closed room from K Cy and

H_2SO_4 is very effective, but is equally fatal to man or beast that may enter the room, before it has been thoroughly aired.

Other members of the *Bug* family are **Acanthia Pipistrella, Reduvius Personatus**, which lives mainly in woods and has been known to bite man producing large and painful swellings; the **Harpactor Cruentus** of Southern France; the **Eulyes Amæna** of Borneo and Java; the Arilus Serratus of Brazil; the **Nepo Cinerea** or water scorpion which bites painfully; and **Notonecta Glauca**, the bite of which causes considerable suffering. It is not recorded that these bite animals but their attacks on man are suggestive.

LICE. PEDICULIDÆ. MALLOPHAGA.

Blood-suckers: Long narrow head, protractile piercing, suctorial tube. *Bird-lice*, Broad Head, biting mandibles. *Lice of solipeds: Big-headed horse louse, Hæmatopinus macrocephalus. Ass-louse, H. Colorata*, black, light spot on sternum. *Hairy bird-louse of solipeds, Trichodectes pilosus. Downy bird-louse, T. pubescens*, smaller than last. **Lice of Ox**; *Large-bellied louse, H. Eurysternus; Narrow-nosed louse, H. Tenuirostris; Scaly bird-louse, T. Scalaris.* **Lice of small Ruminants**; *Round-headed bird-louse, T. Spaerocephalus; Narrow-headed blood-sucker, H. Stenopsis; Bird-louse of Goat, T. Climax*, on common goat, angora, kangaroo and Guinea-pig. **Lice of Camel and Pig,** *H. Suis, H. Cameli*, largest hæmatopinus. **Lice of Dog and Cat,** *Hairy dog-louse, H. Piliferus*, head nearly as broad as long, yellowish gray, abdomen same, thorax brown, dog and ferret. *Broad bird-louse, T. latus*, head broader than long, yellow with dark spots, harbors larval Tænia Canina. *Narrow-nosed bird-louse, T. subrostratus*, head longer than broad, pointed, bright yellow, thorax same, abdomen dull white, on cat. **Rabbit-louse,** *Large-bellied blood-sucker, H. Ventricosus*, head conical, thorax broader than long, abdomen round, head and thorax chestnut, abdomen dull white. **Lice of Guinea-pig,** *Thin Gyropus*, no piercing tube, narrow head, white or yellow; *Oval Gyropus*, broader head, oval abdomen, white body, dark spots: *Menopon Extraneum*, large, round, vellow head, thorax yellowish white, three sternal spots, abdomen oval, hairy. **Lice of Birds:** Genera: *Ornithobius, Lipiuris, Gonioides, Goniocotes, Decophorus, Trinoton, Colpocephalum, Menopon. Symptoms:* Irritation, slight or causing rubbing, to ulceration, sloughing or abscess, staring coat, ruffled feathers. *Symptoms in Solipeds*, chiefly on mane, forelock, tail and adjacent parts. *Symptoms in Cattle*, chiefly on ears, spine, neck, chest, rump. *Symptoms in Sheep and Goat*, cuts and mats wool, great itching. *Symptoms in Pig*, rubs, bites, scratches, rolls in mud. *Symptoms in Dog*, irritation, scratching, depilation, abrasions, erup-

tions, sloughs. *Symptoms in Cats:* licks, bites, scratches. *Symptoms in Birds:* head, neck, under wings, erect feathers, pecking, scratching, flapping wings, rolling in dust. In all genera, can find nits and lice. *Prevention:* Exclude infected; carbon bisulphide in open bottles in empty building, clean, and dust thickly with quicklime, wash with bleaching powder, creolin, tar water, naphthalin, mercuric chloride, potassium sulphide, fumigate often. *Treatment:* Mercurial ointment, tar, tobacco, sulphur, potassium sulphide, calcium sulphide, hellebore, naphthalin, creolin, insect powder often repeated or in dust baths, sulphur smoke bath, oil whole surface, etc.

The parasites known as lice belong to two very different families, the *Pediculidæ* and the *Mallophaga*. Both are wingless and compulsory parasites but they differ essentially in the structure of their head, and proboscis and their manner of feeding.

The **Pediculidæ** (Hæmatopinus) are characterized by a long, narrow head and a protractile sucking proboscis, formed of an external soft sheath with two lips, the lower having one or two hooks, and within these a hollow stylet by which the skin is perforated and the blood drawn.

The **Mallophaga** or *Bird Lice* (Trichodectes) have the head broader than the prothorax and are furnished with no sucking tube, but bite the skin with their short, but powerful, curved and usually serrated mandibles. They live on cuticular structures, epidermis, exudates, scabs, hairs or feathers.

LICE OF HORSE, ASS AND MULE.

Hæmatopinus Macrocephalus. Large Headed Horse Louse. Head very long and narrow, much longer than the thorax; antennæ long and starting from special tubercles; abdomen oval, narrowed in front, with sinuous margins, having stigmata, one on each ring; head and abdomen yellowish gray; thorax brown maroon. Length 2.5 mm. to 3.5 mm.

Hæmatopinus Colorata, found on the ass, seems to be a mere variety of the last, being a little larger, with fewer hairs on the head, a darker color, and a quadrilateral spot of color on the sternum.

Trichodectes Pilosus. Hairy T. Head slightly wider than long, rounded in front, abdomen elliptical, color yellow with brown spots, thorax brown, body hairy. Length 1.6 mm. to 1.9 mm. Horse, ass and mule.

Trichodectes Pubescens. Downy T. This is smaller than the last and has the hairs on the head confined to the margins.

LICE OF OX.

H. Eurysternus (euros broad): **Large Bellied Cattle Louse.** This is fawn colored, with yellow or gray abdomen, distinguished by its very large, oval abdomen. Length 2.5 to 3 mm.

H. Tenuirostris : Narrow Nosed H. This is rarer and smaller than the last, and has its head terminated in a narrow cone where the eurysternus is rounded. The head is inserted in deep notch in prothorax. Length 2.5 to 3 mm. Probably *H. Vituli* of calf.

T. Scalaris. Scaly T. Head slightly longer than broad, rounded in front, very hairy, but fewer on last segment than *T. Pilosus*. Length 1.5 mm. On ox and (perhaps accidentally) on the ass.

LICE OF SHEEP AND GOAT.

H. Stenopsis (stenos narrow). Head long, narrow, conical, round in front, notched laterally, broadening to the thorax; thorax very short; abdomen long, oval, with sinuous borders. Straw-yellow, abdomen grayish. Length 1.5 to 2 mm. On goat.

H. Ovillus. Attacks face of sheep. Scotland, W. Evans. Ann. Scott. Nat. Hist., 1907.

Trichodectes Spaerocephalus (sphaer sphere) **Round Headed T.** Head broader than long and in front than behind, rounded in front, antennæ hairy, abdomen elliptical, transversely elongated dorsal spot on each ring. Length 1.5 mm. Has been found on sheep and goat.

T. Climax (Capræ) (klimax ladder, inclined) **T. of Goat. Scaly T.** Head as broad as long, with broad, shallow notch in front; abdomen conical, especially in the male, in which it terminates in two hairy pads. Head and thorax reddish brown, abdomen pale yellow; length 1.3 to 1.6 mm. On common and Angora goats; claimed to be on kangaroo and Guinea-pig.

LOUSE OF CAMEL AND PIG.

H. Cameli. Rare. Described as resembling *H. Urius* of swine.

H. (Urius) Suis. The largest known hæmatopinus. Head narrow, forming a very long cone, round in front; antennæ long and hairy with sharp horny process on first article; abdomen an elongated oval. Head, abdomen and legs grayish yellow. Length 4 to 5 mm. On pig, probably the same on camel.

LICE OF DOG AND CAT.

H. Piliferus. Hairy H. So named because of the long hairs on head, antennæ, body and limbs. Head short, nearly as broad as long, anterior half narrowing, thorax notched in the centre by head and abdomen, abdomen a broad oval. Head and abdomen yellowish gray, thorax maroon brown, legs yellow. Length 1.5 to 2 mm. On dog and ferret.

T. Latus. Broad T. Head much broader than long; antennæ hairy, the first segment in the male equalling both the others; abdomen very broad and rounded. Color bright yellow with darker spots. Length 1.5 mm. Sometimes the abdomen, abnormally enlarged, encloses the encysted larva of the tænia canina of the dog. On dog.

Trichodectes Subrostratus. Narrow-Nosed T. Head longer than broad, pointed in front, abdomen elliptical, in male conical behind with downy extremity. Head and thorax bright yellow, abdomen dull white. Length 1.2 mm. On the cat.

LOUSE OF RABBIT.

H. Ventricosus, Large Bellied H. Head broad behind, narrowed in front, like an awl handle; thorax broader than long; abdomen round almost as broad as long, with eight wrinkled rings; hairy; head, thorax and legs chestnut, abdomen dull white. Length 1.3 mm.

LICE OF GUINEA-PIG.

Gyropus Gracilis. (gyrus circle). **Thin G.** As one of the bird lice (non suckers) this is remarkable for the narrowness of both head and body; the head and thorax are about $\frac{1}{12}$th of the entire length, the abdomen about $\frac{1}{8}$th. Length 1.2 mm. Antennæ and legs short; color white or yellowish.

G. Ovalis. Oval G. This is distinguished by its broader head, and its broad oval abdomen with two rows of hairs on each ring. Body white, with dark spots; tarsi and claws black. Length 1.2 mm.

Menopon Extraneum. Foreign M. Head large, temples round, with three long and three short hairs; thorax longer than the head with three sternal spots; abdomen oval, hairy. Head and spots yellow, thorax yellowish white, bands black. Length 1.7 to 2 mm.

LICE OF BIRDS.

The lice infesting birds are so numerous that a full description of each may be omitted. In place of this we append the characters of the different genera, and the student will find the species and their various hosts named in the general list.

Genus **Ornithobius.** Body long, narrow, sides almost parallel; antennæ in 5 segments, the two first being the longest in the males, a temporal band forms a fold behind the eyes; last abdominal segment is pointed in the male. The one species, **O. Bucephalus** of the SWAN is 3.5 mm. long.

Genus **Lipiurus**. Body long, narrow, sides almost parallel, antennæ in 5 segments, the third bearing an appendix in the male, last abdominal segment in male notched. Nine species are described as infesting birds, the pigeon (1), chicken (2), pheasant (1), turkey (1), guinea-fowl (1),duck (1) and goose (2).

Genus **Goniodes** (gonios corner). Body flat, broad, abdomen oval; antennæ supported in sinus behind a prominent angular tubercle, and formed of 5 segments, the first segments in the male being larger than the others, and the third bearing an appendix which is absent in *Goniocotes*. Behind this is a prominent temporal angle. Eight species are described as infesting birds, the pigeon (1), hen (1), pheasant (2), turkey (1), Guinea-fowl (1) and pea-fowl (2).

Genus **Goniocotes**. Body flat, broad; head has two angles on each side, an anterior (temporal) bearing two hairs, and a posterior (occipital), the latter bearing a short spine. Five species are described, in chickens (2), pigeons (1), pheasant (1), pea-fowl and Guinea-fowl (1).

Genus **Decophorus**. Body flat, broad; forepart of head (clypeus) separated from the hinder part by a suture; anterior angle of the sinus attaching the antennæ, has a movable tubercle; antennæ in 5 segments, the same in both sexes. Two species are described, in duck and goose, respectively, the one probably a variety.

Genus **Trinoton**. Head very much rounded in front, and laterally at the temples, a wide orbital cavity and eye in two lobes, the antennæ short and hidden; thorax in three segments; tarsi bear two claws. Four species are described, in duck (1), goose (2), and swan (1).

Genus **Colpocephalum**. (Colpos bay, pocket). Head broader than long; resembles *trinoton*, but the eyes are rarely bilobed, and antennæ are longer and more evident. Tarsi bear two claws each. The *long tailed Colpocephalus* infests pigeons.

Genus **Menopon**. Head broadens backward to the temporal region; orbital sinus varies in size and is occupied in whole or in part by the eye; the short antennæ may be folded back in the orbital cavity; often median spots on sternum. Ten species have been described, in pigeon (1), chicken (2), pheasant (2),

turkey (1), pea-fowl (1) Guinea-fowl (1), duck (1), and Guinea-pig (1).

Symptoms of Lice. The itching, rubbing, scratching and biting vary with the kind of parasite and the numbers present. The hæmotopinus or bloodsuckers are naturally the most irritating, while the mallophaga or bird lice which merely bite through the epidermis with their dentated mandibles and suck the exuding liquids of the skin are much less annoying. Yet even these by biting and creeping cause a formication which leads to active rubbing, scratching or biting and to the formation of abrasions, erosions, and sometimes even sloughs and small abscesses. Short of these there is habitual erection or shedding of the hair and feathers.

Symptoms in Horse, Ass and Mule. The bloodsuckers are mostly found where they can get the shelter of long, coarse hair (mane, forelock, tail and neighborhood), and their presence on the animal may be suggested by the stiff erect hairs, the excess of dandruff or scabs with *nits*, and the intense itching, which causes violent rubbing against stalls, posts, trees, fences, harness, etc., biting of himself, and appeals to be nibbled by others. On parting the hairs and looking closely into the affected parts the hæmatopini can be detected, usually with the head and proboscis fixed in the skin and the abdomen showing outward. Railliet has seen them in clusters under the epidermis forming little black tumors. The bird lice are less common in solipeds, and are found especially on the withers, sides of the neck and chest, and (less frequently) the limbs. These produce far less itching or irritation than the hæmatopinus, and when puritus is marked it is well to see whether the bloodsuckers, or acari, are not also present.

Symptoms in Cattle. The trichodectes are the most common, and though found on all parts of the body produce less irritation than the hæmatopinus. The latter attacks especially the parts with long hairs, and which cannot be so readily reached with the tongue (roots and tips of ears, the spine, the sides of neck and chest, and the base of the tail). The animal rubs violently on posts and all available firm objects, licks the parts, rubs them with the horns, and with its hind feet. If within reach of the tongue the hair is turned the wrong way or matted, elsewhere

it is erect, with round bare patches of skin, crusts and scabs. The detection of the lice is conclusive.

Symptoms in Sheep and Goat. The only species is a trichodectes, which cuts through the wool, leading to matting (clapping), the detachment of tufts and exposure of the deep whiter layers, and to persistent rubbing, biting and scratching. The lice are often in groups, close to the roots of the wool, and the adjacent skin shows spots of red up to ⅓ inch in diameter, with more or less scurffy debris, nits and exuvia. Low condition if not present as a predisposing cause usually follows invasion by lice. In the angora the fleece is greatly depreciated.

Symptoms in Pig. Harboring the largest known hæmatopinus, the pig suffers greatly from its attacks. It rubs violently on wall, trough or posts, bites and scratches, when free seeks to plunge in water or liquid manure, and the skin shows excoriations and erosions of all degrees of severity. The hæmatopini are found at the roots of the ears, inside the legs, along the belly and elsewhere with heads turned in toward the skin and the sucking tube imbedded in it. As in other animals the parasites are likely to prevail in neglected herds, where neither feeding nor cleanliness are duly attended to, and when very abundant they cause great emaciation, debility and even death.

Symptoms in Dog. The *hæmatopinus piliferus* is found especially in long-haired dogs, and about the neck. It causes much irritation, sleeplessness and scratching with the production of depilation, excoriation, scurf and scab, in the midst of which the parasite may be detected. The trichodectes is often present in weak subjects (the very young or the very old), and is much less injurious, though invading the entire skin.

Symptoms in Cat. The *trichodectes subrostratus* may invade the whole body, yet is not very injurious, unless when in very large numbers in the young or old. The cat licks, bites and scratches the parts as it would with fleas. By parting the fur the parasites can be easily found.

Symptoms in Birds. With the great variety of bird lice and their different habits, the part of the body attacked and the resulting irritation vary. The body, particularly under the wings, forms a favorite seat, though in other cases the neck and head are invaded, manifestly as being out of the way of the beak. Some,

like the *decophora*, migrate to the head after the death of the host. The itching seems to be greatest during hot or cloudy weather, the birds erecting the feathers, pecking, scratching, flapping the wings, rolling and scratching in a dust bath, abandoning their nests, and rapidly losing condition. The picking out of feathers, the quills of which have been invaded by lice, gives the appearance of unseasonable moulting. A variety of different species may be found on the same bird, accompanied by their nits, if that is their normal host, or without nits if only transient parasites from birds of another kind.

Prevention. This consists in the destruction of the lice and nits in the houses and yards, and the exclusion of all infested birds. Schneider advises carbon bisulphide in open bottles in the closed buildings from which the animals are excluded. This is only safe if lights are excluded. Zurn found free dusting with freshly burned quicklime effectual, (walls, ceiling, floor, nests, roosts, troughs, and yards). For birds especially this is useful as the scratching keeps the lime floating on the air and destroys the lice on the birds at the same time. In a few minutes the lime may be swept out and buried, or placed in the manure pile. Whitewashing, or washing with a solution of chloride of lime, tar, phenol, cresol, creolin, napthalin, mercuric chloride, copperas, or potassium sulphide, is desirable and may be repeated twice a year. To complete the purification fumigate thoroughly with sulphur. Yards may be sprinkled freely with one of the above, and should be kept clear of manure and filth which would cover and protect the parasites.

Treatment. This consists in the destruction of the lice and their *nits*. Certain agents are effective even if not applied over the entire affected skin. Mercurial ointment rubbed in small amounts back of the horns or ears, where the tongue cannot reach, will usually be absorbed so as to kill all the lice on the body. If, however, applied over a considerable surface it is liable to salivate and especially in cattle. Tar has been similarly used, and a weak tar water may be applied more freely over the body. Tobacco decoction (1:10) may be used very advantageously for the herbivora, whereas it is to be dreaded in vomiting animals (omnivora and carnivora).

For more general application we may use sulphur ointment (1:3 or 4) ; potassium sulphide solution (1:10); calcium sulphide

solution (4:100; or sulphur 12, unslacked lime 8, water 50 gallons: boil); oil of tar liniment (1:20 of olive oil); oil of cade liniment (1:15); black hellebore decoction (1½ oz. : 1 qt.); oil of lavender or oil of spike 1, alcohol 10; creosote in vaseline (1:4); napthalin in vaselin (1:5); creolin solution (1:10); benzine 1, soft soap 6, water 20; or stavesacre 2 ozs., water 1 qt. Powders may be employed: thus Persian insect powder, snuff, napthalin or powered walnut leaves may be blown on the skin having raised the hair, fur or feathers for the purpose. Whatever agent is used it should be repeated in eight days to destroy the products of the *nits* that escape at the first dressing.

In the case of birds the dry powders can be advantageously put in a dust bath. A box with dry, powdered clay or loam, is medicated with quicklime, oil of tar, phenol, insect powder, stavesacre, snuff, or napthalin, and placed where it will be kept dry and within easy reach of the birds. Driven by the itching they will resort to this bath at intervals and quickly destroy all lice on their bodies.

Baths of sulphur smoke have been employed. A small box is made with a hole through which the head is made to protrude. The bird having been placed in position a match is burned in the box and in a few minutes all the vermin on it are killed.

In the absence of the active insecticides it is well to bear in mind that a thorough inunction with sweet oil, lard or any bland oil will kill the lice by closing their breathing stigmata.

For sheep in large flocks baths are the natural resort, and for these the reader may see under *acariasis*.

All clothing should be boiled or heated to the boiling point to destroy the nits and mature lice.

CLASS. ARACHNIDA.

ORDER ACARINA, MITES, TICKS.

SUPERFAMILY: IXODOIDEA, TICKS.

FAMILIES: ARGASIDÆ: IXODIDÆ.

Family ARGASIDÆ.

Subfamily: **Argas**, **Ornithodorus**.

Family IXODIDÆ.

Subfamily: **Rhipicephalinæ**, **Ioxdinæ**.

Subfamily: RHIPICEPHALINÆ.

Genera: **Rhipicephalus**, **Hæmaphysalis**.
Margaropus: (**Boöphilus**,) **Dermacentor**.

Subfamily: IXODINÆ.

Genera: **Ixodes**, **Amblyomma**,
Eschatocephalus, *Hyaloma*.
Aponomma.

GENUS RHIPICEPHALUS.

Species: *R. Pulchellus*, **R. Texanus**,
R. Perpulcher, *R. Capensis*,
R. Brevicollis, *R. Evertsi*,
R. Sanguineus, *R. Bursa*,
R. Paulopunctatus, *R. Simus*,
R. Punctatissimus, *R. Compositus*,
R. Rutilus, *R. Carinatus*,

GENUS MARGAROPUS, (BOÖPHILUS).

Species: **M. Annulatus. B. Bovis.** *Rhipicephalus*, (*Boöphilus*,) *Annulatus*, *Ixodes Bovis*, *I. Dugesii*, *I. Plumbeus*, *etc.*
M. Caudatus. *Rhipicephalus Caudatus.*
M. Decoloratus. *R. Decoloratus.*
M. Australis. *R. Australis.*
M. Calcaratus. *R. Calcaratus.*
M. Rosea. *Hæmaphysalis Rosea.*

GENUS HÆMAPHYSALIS.

Species: *H. Leporis Palustris*, *H. Papuana*,
H. Cordeilis, *H. Bispinosa*,
H. Rhinolophi, *H. Concinna*,

H. Erinacei,
H. Sanguinolenta,
H. Punctata,
H. Cinnaberina,
H. Flava,
H. Hirudo,
H. Elongata,
H Leachi,
H. Spinigera,
H. Cornigera.

GENUS DERMACENTOR.

Species: *D. Nitens,*
D. Reticulatus,
D. Electus,
D. Variegatus,
D. Rhinocerotis,
D. Circumguttatus,
D. Parvus,
D. Nigrolineatus.
D. Variabilis,
D. Albipictus,
D. Parumapertus,
D. Parumapertus v. Marginatus,
D. Yenustus,
D. Occidentalis,

Subfamily: IXODINÆ.

Genera: **Ixodes,**
Eschatocephalus,
Aponomma,
Amblyomma,
Hyalomma.

GENUS IXODES.

Species: **I. Ricinus,** (Castor bean tick.)
I. Loricatus,
I. Hexagonus,
I. Ovatus,
I. Rasus,
I. Holocyclus,
I. Pilosus,
I. Thoracicus,
I. Californicus,
I. Scapularis,
I. Dentatus,
I. Cookei,
I. Obscurus,
I. Precoxalis,
I. Bifurcatus,
I. Spinicoxalis,
I. Putus,
I. Eudyptidis,
I. Intermedius,
I. Angustus,
I. Ornithorhynchi,
I. Tasmani,
I. Lævis,
I. Luteus,
I. Spinosus.
I. Diversifossus,
I. Frontalis,
I. Dentatus,
I. Fossulatus,
I. Affinis,

GENUS ESCHATOCEPHALUS.

Species: *E. Gracilipes* (Vespertilionis).

GENUS APONOMMA.

Species: *A. Gervaisi,*
A. Exornatum,
A. Decorosum,
A. Trachysauri,

A. Transversale,
A. Læve,
A. Politum,
A. Concolor,
A. Hydrosauri,
A. Trimaculatum.

GENUS AMBLYOMMA.

Species: **A. Americanum,**
A. Cajennense,
A. Multipunctum,
A. Crassipunctum,
A. Calcaratum,
A. Varium,
A. Cœlebs,
A. Fossum,
A. Scutatum,
A. Nodosum,
A. Sparsum,
A. Dissimile,
A. Hippopotamense,
A. Variegatum,
A. Annulipes,
A. Rugosum,
A. Maculatum,
A. Ovale,
A. Triguttatum,
A. Hassalli,
A. Splendidum,
A. Concolor,
A. Geayi,
A. Paulopunctatum,
A. Eburneum,
A. Subluteum,
A. Hebræum,
A. Marmoreum,
A. Moreliæ,
A. Limbatum,
A. Latum,
A. Striatum,
A. Cuneatum,
A. Sylvaticum,
A. Fodi,
A. Gypsatum,
A. Cyprium,
A. Quadrimaculatum,
A. Goldii,
A. Testudinarium,
A. Humerale,
A. Thollona,
A. Tuberculatum,
A. Fulvum,
A. Albipictus,
A. Decoratum,
A. Læve,
A. Crenatum,
A. Breviscutatum,
A. Pilosum,
A. Extraoculatum,
A. Parviscutatum,
A. Sahaneræ,
A. Vittatum,
A. Cordiferum,
A. Sublæve,
A. Diminutivum,
A. Dubitatum,
A. Acutangulatum,
A. Aureum,
A. Devium,
A. Giganteum,
A. Avicola.

GENUS HYALOMMA.

Species: *H. Crassitarsus.* *H. Ægyptium.*
H. Affine.

Family ARGASIDÆ.

Genus: ARGAS. Flat body. Proboscis beneath cephalo-thorax: eyes wanting. Bloodthirsty and often venomous.

Species: **A. Americanus.** Mammals. Texas.
A. Breviceps.
A. Chinche. Mammals. Columbia.
A. Talaje. Mammals. Mexico.
A. Coriaceus. Mammals. Mexico.
A. Persicus. Venomous bug of Miani. Man, Fowls, Persia. Very venomous.
A. Tholazani. Body narrow. Man, Sheep, Mammals. Persia.
A. Pipistrellæ. Mammals. Europe, Asia, Africa, America.
A. Mauritianus. Poultry yards in Mauritius.
A. Miniatus. Poultry (Ox?). America. S. States.
A. Reflexus. Pigeons, man.

Genus: ORNITHODORUS. Oval body; lateral margins straight; hood curved ventrally; eyes present or absent.

Species: **O. Turicata.** Man, pig, fowl. S. America, Mexico, Gulf States, United States. Often fatal.
O. Talaji. O. Coriaceous. O. Ægyptius.
O. Megnini. Spinous ear tick. Lyre-shaped. Cattle, horse, ass, dog, sheep, man. Mexico.
O. Savignyi. GIANT TICK. Man, Mammals. Senegal, Africa, Guadaloupe. Very injurious. Causes farcy in cattle.

Family GAMASIDÆ.

Genus: GAMASUS. Coriaceous integument. Mandibles with claws. Larva hexapod. Lives in musty hay, manure, etc.

Species: G. PTEROPTOIDES. Body small, brown, ovoid, legs long with claws. Fur of moles, field mice and rabbits.
G. FENILIS. Musty hay. Accidentally on mammals.

Genus: DERMANYSSUS. Acari of poultry house. Soft integument. Oviparous. Larva hexipod.

Species: **D. Gallinæ (Avium).** Birds. Hen manure, roosts, etc. Man, mammals.
D. Hirundinis. D. of Swallow and **Phoebe.** Probably a variety.

Family TROMBIDIIDÆ.

Genus: TROMBIDIUM. RED MITE. HARVEST MITE. Larva on man and beast.

Species: T. **Holosericium.** Scarlet. Gardens, warm places. Europe. Mammals. Larva in skin.

T. **Americana.** Dull red. Warm places. America. Summer. Larva in skin. Man and beast.

Sub-Family TETRANYCIDÆ.

Genus: TETRANYCHUS (tetra four, önyx claw). Live on plants and animals.

Species: T. **Molestissimus** (BICHO COLORADO). Attacks mammals. Buenos Ayres. Uruguay.

Sub-Family CHEYLETINÆ.

Genus: CHEYLETUS. Soft skin. Maxillary articles have recurved hooks.

Species: CH. PARASITIVORAX. Ovoid, grayish yellow, thick rostrum, in fur of rabbits.

CH. HETEROPALPUS (éteros different). Yellow, lozenge shape. Rostrum thin cone. Plumes of pigeons.

CH. ERUDITIS of old books. Accidentally on animals.

Genus: HARPIRHYNCHUS (ärpe sickle). Rostrum short, palpi thick. Second article with three hooks turned up and back.

Species: H. **Nidulans** (nesting). In tumor-like clusters on skin of pigeons, etc.

Genus: SYRINGOPHILUS. Long wormlike body. Small palpi. In quills.

Species: S. PECTINATUS. COMB-LIKE S. Narrow body. Anterior part the broader. Foot with two claws and two bristles. Quills. Chickens, guinea-fowl and pigeons.

S. UNCINATUS. Palpi with larger hooklets. Probably a variety.

Family SARCOPTIDÆ (sarx flesh, koptein to cut).

Minute acari, rostrum an imperfect sucker. Chelicera with two claws. Maxillary palpi with three articles. Hexapod larva.

Sub-Family TYROGLYPHINÆ (tyros cheese). CHEESE EATERS. S. DETRITICOLA. Live on decomposing organic matter.

Genus: TYROGLYPHUS (tyros cheese, cheese scooper). With smooth hairs and caruncle on tarsus. Males with copulating bursa.

Species: T. SIRO (siros pit). On cheese, farina, etc. Accidentally on animals.

T. LONGIOR. LONG T. On same.

Genus: GLYCIPHAGUS (glycys sweet, phagein to eat).

Species: G. CURSOR. WANDERING G. (SARCOPTES HIPPOPODOS?) In farina, on carcases, meat, etc.

Sub-Family LISTROPHORINÆ (listreuo to dig) (S. GLIRICOLA).

Genus: LISTROPHORUS. Ovoid body. Broad shield on head and thorax. Lips prolonged as pincers. Lives in hair.

Species: L. GIBBUS. HUNCHED L. Shield notched above. Male with flat bifid posterior appendix. Fur of hares and rabbits.

L. MUSTELÆ. Shield divided transversely in two. Male notched at caudal extremity. Fur of ferrets, etc.

Sub-Family ANALGESINÆ (analgesia want of feeling). S. PLUMICOLA). In plumes. On plumules in summer; in quills or cutaneous follicle in winter or when moulting. Males with copulatory sac.

FREYANA ANATINA. Duck, turkey.

PTEROLICHUS OBTUSTS. Partridges, pheasants.

FALCIGER ROSTRATUS. Pigeons.

MEGNINIA GINGLYMURA. Pheasants.

M. CUBITALIS. Chickens.

M. ASTERNALIS. Chickens, pigeons.

M. VELATA. Duck.

PROCTOPHYLODES (PTEROPHAGUS) STRICTUS. Pigeons.

DERMOGLYPHUS ELONGATUS. (glypheys carver). Chicken.

D. (ANALGES) MINOR. Chicken.

D. MINOR VAR. SIMILIS. Guinea-fowl.

D. VARIANS. Guinea-fowl.

Sub-Family SARCOPTIDÆ EPIDERMICOLA (sarx flesh, kopto to cut). EPIDERMOPTES BILOBATUS, (SYMBIOTES AVIUM). E. BIFURCATUS.

Sub-Family Cytoditinæ (cyton hollow). SARCOPTIDÆ CYSTICOLA).

Genus: **Cytodites (Cytoleichus)** (leicho to lick up). Round body, conical rostrum, tubular sucker.

Species: **C. Nudus.** Body round, smooth, hairless. In air sacs of thorax, abdomen, bones of gallinaceæ.

Genus: SYMPLECTOPTES (symplectos entangled). Body oblong; transverse groove between the second and third pairs of limbs; legs short, with suckers.

Species: **S. Cysticola (Epidermoptes Cysticola).** Live in epidermis, cutis, loose subcutaneous connective tissue.

Sub-Family SARCOPTINÆ. Acari of scabies, mange, body ovoid, convex above, flat below; shields; bristles.

Genus: SARCOPTES (coptein to hide). Males without ambulatory suckers on third pair of legs, or copulatory suckers. Females have suckers on two first pairs only.

Species: **S. Scabei (Communis).** Burrow under epidermis.

Varieties: **S. Scabei v. Hominis.** Man.
S. Scabei v. Equi. Horse, ass, mule.
S. Scabei v. Ovis. Sheep, gazelle, moufflon.
S. Scabei v. Capræ. Goat.
S. Scabei v. Suis. Pig, dog.
S. Scabei v. Lupis. Wolf, dog, deer, man (Norwegian itch).
S. Scabei v. Cameli. Camel, llama, giraffe, antelope.
S. Scabei v. Canis. Dog.
S. Scabei v. Hydrochœri. Ferret.
S. Minor (Notoedris). **Small S.** Cat, rabbit, coati, rat.
S. Mutans (changing). Under leg scales of birds.
S. Lævis (polished).
S. Lævis. v. Columbæ. Pigeon.
S. Lævis v. Gallinæ. Chicken, gallinaceæ. Depluming mange.

Genus: PSOROPTES (psora itch). Lives on skin among scales.

Species: **P. Communis (Longirostris).** Rostrum a long cone; third pair of legs end in bristles in the mature. Causes scabies.

Varieties: **P. Communis v. Equi.** Horse. General surface.
P. Communis v. Bovis. Ox. General surface.

P. Communis v. Ovis. Sheep. General surface.

P. Communis v. Capræ. Goat. General surface.

P. Communis v. Cuniculi. Rabbit. General Surface.

Genus: SYMBIOTES (sym together, bios life).

Species: **Symbiotes Communis.** On one part; usually limbs; foot mange. Male has two caudal lobes.

Varieties: **S. Communis v. Equi.** Horse. Feet and legs.

S. Communis v. Bovis. Ox. Feet and legs.

S. Communis v. Ovis. Sheep. Feet and legs.

S. Communis v. Capræ. Goat. Feet and legs.

S. Communis v. Cuniculi. Rabbit. Ear.

Symbiotes Auricularum. (Ecaudatus). Male without caudal lobes. In concha, dog, cat, ferret.

Symbiotes Setifer (seta bristle) Fox, hyena (dog?).

Symbiotes Avus. Ancestral S. Sparrow.

Family DEMODICIDÆ.

Very small, soft, hairless, wormlike acarina. Legs rudimentary, abdomen prolonged. Inhabit sebaceous and hair follicles. Mammals.

Genus: DEMODEX.

Species: **D. Folliculorum. D. of Follicles. Steatozoon F.**

Varieties: **D. Folliculorum v. Hominis.** Man. Mostly on face.

D. Folliculorum v. Canis. Dog.

D. Folliculorum v. Felis. Cat. Nose, ear.

D. Folliculorum v. Capræ. Goat.

D. Folliculorum v. Suis. Pig.

D. Folliculorum v. Ovis. Sheep. Meibomian glands.

D. Folliculorum v. Bovis. Ox, Muzzle, neck and shoulder.

D. Folliculorum v. Equi. Horse. Meibomian glands.

D. Folliculorum v. Cuniculi. Rabbit.

LINGUATULIDÆ (lingua tongue). PENTASTOMIDÆ (pente five, stoma mouth).

Vermiform arachnidæ; body annulated; mouth with two pairs hooklets; parasitic on vertebrates; mature and larval forms in different hosts.

Genus: LINGUATULA.

L. Tænioides (tænia shaped). MATURE FORM in nasal chambers and sinuses of dog, horse, mule, wolf, sheep, goat, man.

L. Denticulatum. LARVAL FORM in liver, lungs, kidney, mesenteric glands, intestinal submucosa, eyeball of sheep, goat, antelope, deer, dromedary, ox, horse, Guinea-pig, cat, etc.

Order SCORPIONIDA.

About twenty species in the Southern States. None North. Are nocturnal. Each has a large, caudal poison sting. Rarely fatal to man or domestic animal.

Order ARANEIDA. SPIDERS.

Abdomen unsegmented. Attached to thorax by a narrow stalk.

Eurypetnea Hentzii. Tarantula. Largest spider of Southern States. Bite is venomous, but not very dangerous.

Order HYMENOPTERA (hymen membrane, pteron wing).

BEES. WASPS. ANTS.

Wings four, membranous, few or no veins. Abdomen in female and workers usually with a sting.

Sub-Order ACULEATA.

Family VESIPIDÆ. SOCIAL WASPS.

Genus: **Vespa, yellow jacket, hornet.**

Genus: **Polistes.** Abdomen long, spindle-shaped, black, with yellow rings.

Genus: **Polybia.** On Pacific Coast. In numbers may sting large animals to death.

Family ALPINA. BEES.

Genus: **Bombus. Bumble-bee.**

Genus: **Apis. Honey-bee.** In numbers stings may be dangerous.

Super-Family. FORMICINA. ANTS.

Family. **Formicidia.** TYPICAL ANTS.

Bite, but don't sting.

Family. **Ponderina.**

Queens and workers sting.

Family. **Myricidæ.**

Queens and workers sting. Formic acid of bees and ants is painfully irritating.

ACARINA. ACARI. MITES. TICKS.

These belong to the class *Arachnida* which includes, *spiders* and *scorpions* as well as *mites*, and *ticks*. As common characters it may be noted that the head and thorax have become confluent (cephalo-thorax), that the mature forms have four pairs of legs, and are devoid of antennæ.

Acarus, Mite. These have head, thorax and abdomen confluent, so as to form one continuous mass. Some species however show a groove between the head and thorax and others also between the thorax and abdomen. Many have the chitinous surface marked by fine transverse striæ and growing a few hairs. The acari are mostly very small, almost microscopic. They are air breathing by 2 stigmata, have the sexes in different individuals and are oviparous (one family is viviparous).

The successive stages of development may be thus stated :

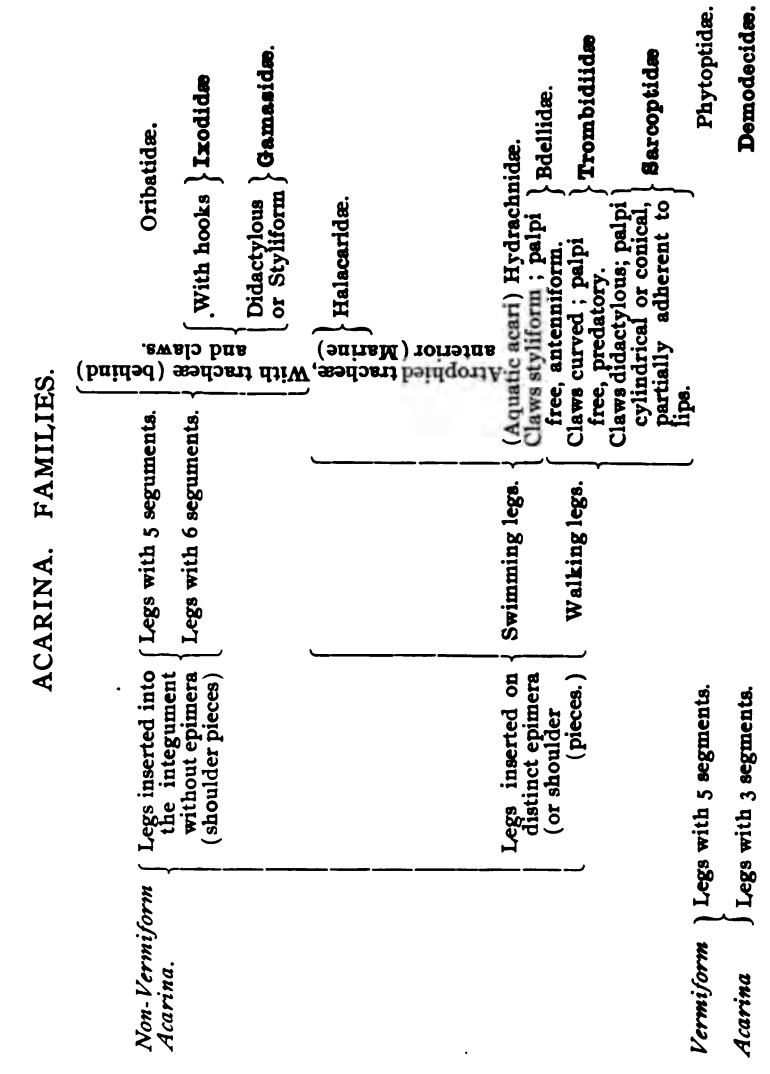
1. The *ovum*.
2. The *larva* with six legs (*hexapod*); has two abdominal bristles which may represent the missing pair of legs ; sexually immature ; moults 2 or 3 times.
3. *Nympha* with eight legs (*octopod*); asexual ; moults once.
4. *Sexually mature male and female.*
5. *Ovigerous female.*

The table on page 132 gives prominent distinctive features of the different families of acarina, the parasitic families being given in black-faced type.

HABITS AND PATHOGENESIS.

The ticks are temporary parasites, many attacking all or nearly all terrestrial vertebrata and so far as the nymphæ and males are concerned parasitism is not obligatory and they show often very little preference for one genus over another. The ovigerous females on the other hand are compulsory parasites and usually show a very marked preference for a given genus or species, so that the absence of that genus is often equivalent to the extinction of that race of ixode. An infection bearing tick may however perpetuate its existance by sucking the blood of animals that are insusceptible to the germ that they habitually transfer, and are ready to transfer such germ from

ACARINA. FAMILIES.



any infected animal that may be introduced. Thus the Margaropus (Boöphilus) annulatus can live on the horse, sheep and deer, none of which takes Texas fever, cattle only do.

They are found especially in uncultivated lands, wooded or covered with brush or tall, coarse vegetation, where they may be seen hanging to the leaves by their first pair of feet, while the

others are extended ready to hook on to the first animal that may pass. Hence hunting dogs and cattle are especially liable to be attacked, and hence too the habitual disappearance of ticks from enclosed lands under cultivation. Some individuals have little attraction for the tick and may traverse their haunts with impunity. On the skin the ixode at once inserts its barbed chelicers and dart where they remain firmly fixed while the maxillary palpi remain pressing around the wound and the blood is sucked energetically and rapidly. The hungry tick filling itself with blood may distend itself to ten times its former size, and when gorged it may drop off and remain torpid, until with a new access of hunger, it once more climbs on the vegetation, and lies in wait for an additional victim. The **ovigerous female,** gorged with blood, hides under some object, lays her **eggs** and soon dies. The eggs in favorable conditions hatch into hexapod larvæ in fifteen to twenty days. The **larvæ** may live for months without food, though they are often found also on the skin of animals. The **nymphæ** are larger and octopod, but still lack sexual organs. After a second moulting these form **males** and **females.** The fecundated female is the largest and the most bloodthirsty of the series.

The barbed rostrum inserted in the skin holds so firmly that the body of the parasite may be torn off without dislodging it. If touched with a hot knife blade, or with a drop of oil so as to close its stigmata it detaches itself, often rotating to the left, and it is said that it may be detached by carefully turning the body to the left as in extracting a screw. The skin perforated by the rostrum is irritated and may become the seat of small abscesses, but when the tick is extracted the lesions soon heal. A drop of benzine, kerosene, oil of turpentine, oil of tar, or other insecticide will cause the tick to promptly drop off.

Infection Through Ticks. The Texas fever tick encreases its bulk by 10.000 times during its three weeks of, growth, and even apart from the piroplasma it causes marked anæmia by abstraction of blood and instillation of venom. One to one hundred and fifty ticks on an animal cause marked bloodlessness and debility. Besides the local irritation caused by all ticks and their liability to transfer skin and blood infections, some become the bearers of specific infections, such as the germs of Texas fever, louping-ill,

etc., which will be more appropriately considered under *infectious diseases.*

CHARACTERISTICS OF TICKS.

The ticks are large acarina, always visible to the naked eye, even as embryos, and growing in some instances to half an inch in length when mature, egg-bearing, and filled with blood. All show the successive stages of development seen in other acarina, namely:

Eggs, usually ovoid, with tough, leathery shell.

Larvæ, which are 6 legged and without generative pore or sexual organs.

Nymphæ, half grown females, with 8 legs, but no eggs.

Adult Males, smaller and flatter than the females, but with 8 legs.

Adult (replete, ovigerous) females, 8 legged; fully developed oviducts containing eggs. Fasting, are flat and leathery, but large, soft and rounded when full of blood.

Each tick is naturally divided into *head* and *body.*

1. **Head** (*capitulum*). This consists of the *base*, *2 mandibles*, *dart* and *2 palpi.*

The **base of the capitulum** (*mouth shield*) is a hard, solid segment, usually transversely elongated, and inserted into a notch on the anterior border of the dorsal shield and body. Anteriorly it supports the other elements of the head—the mouth organs. On its upper surface, in females, it bears two porous areas (*areæ porosæ*).

The **mandibles** (*jaws*, *cheliceræ*), right and left, thickened at the base, slightly narrowed toward the free ends, lie above the *dart*, and are each terminated by a *digit* bearing from one to four hooks (apophyses) recurved dorsally, like a harpoon.

The upper surface of the mandibles is sometimes covered by a thin **mandibular sheath** having its exposed surface roughened like a file.

The **dart** (*hypostome*, *labium*, *tongue*, *radula*) lies beneath the two mandibles and is best seen from below. It is somewhat flattened, has a bilateral symmetry, being double, and is covered, more or less perfectly beneath (*ventrally*) or even laterally by *hooks* (*teeth*, *denticles*) which are recurved toward the body.

Near the point of the dart these teeth are small and irregular, but farther back they are larger and are arranged in rows, longitudinal and transverse, the numbers of which, though somewhat variable, are important for identification of species.

The *jaws*, *mandibles* and *mandibular sheaths* when brought together form a central canal or tube through which the blood is sucked. The whole mass is inserted into the tissues and firmly held there by the barbed surface, and has been given the names of **beak**, *rostrum*, *proboscis* or *haustellum*.

The **palpi**, which with the above complete the structures of the head, are two organs, each formed of 4 articles, placed to the right and left of the beak.

2. **Body.** The body has distinct generic or specific characters on its *dorsal* and *ventral surfaces* and on its *margins—lateral*, *anterior* and *posterior*.

Dorsal Structures. These include *dorsal shield*, *eyes*, *porose plates*, *postero-marginal festoons and shields*, *furrows*, *pits*, *punctations* and *hairs*.

Dorsal Shield (*dorsal plate*, *thoracic shield*, *scutum*.) This is a hard chitinous plate found in the Ixodidæ and wanting in Argasidæ. In *males* it covers all or nearly all the dorsal aspect. In *nymphs* it covers the anterior half or more. In *adult females* it is restricted to a small anterior portion of the back. Usually notched anteriorly to receive the *head* it shows at each side a prominent forward projection. It shows a variable number of pores (punctations) with or without hairs.

The **eyes** (ocelli) are two small, semiglobular objects placed one on each lateral margin of the scutum in Ixodidæ; or in pits on the supracoxal fold near legs I in Argasidæ. Absent in some ticks.

The **porose plates** are placed one on each side of the median line about opposite legs III and IV in Rhipicephalus, Margaropus, Dermacentor and Hyalomma. They show a number of wart-like elevations each bearing on its summit a pore in form of a slit.

The **postero-marginal festoons** are only present in certain species like Dermacentor and Amblyomma, which have eleven each.

The Dorsal Furrows caused by contractions of the dorso-ventral muscles, vary in the same individual at different times and may be obliterated by repletion with blood.

Pits, punctations, hairs and spines may be made out by the aid of a good hand lens The pores are of varying size, give passage to hairs or spines and lead to gland tissue beneath.

Ventral Structures. The ventral aspect presents : **Genital pore, anus with anal valve, anal shields, ventral shields, stigmata, furrows or grooves, pits, punctations, hairs,** caudal appendage and legs.

The **genital pore** is a transverse slit crossing the median line, between the first three pairs of legs. It is wanting in the hexapod larvæ.

The **Anus** is between the last pair of legs, in the median line and surrounded by a chitinous valve.

Anal Shields or plates (*clypei*) are found only in the male of particular genera, which have two on each side of the anus.

Stigmata (*stigmal plates, peritremes*) are situated, one near each margin, between the III and IV legs in Argasidæ, and back of the IV pair in Ixodidæ in the octopod stage. In Margaropus Annulatus they are present in the larvæ as well and may be even in three pairs (Stiles). Each bears its *stigmal breathing aperture* or *spiracle*. They are dotted with granules, small and large, the latter being the outer ending of goblet-shaped cells, the size, number and position of which serve to identify the species. They differ in the male and female of the same species.

Two Genital Furrows, beginning one on each side of the genital pore, extend backward, and from near the plane of the IV legs diverge to the postero-lateral borders. The *Anal Furrow* extends backward in the median line.

The **pits, punctations,** and **hairs** have similar characters as on the back.

A hard chitinous **Caudal Appendage** characterizes certain species such as Margaropus *Australis*.

Legs. These are *six in number in larvæ* (hexapod) and *eight* in *nymphæ* and *adults* (octopods). They are indicated as pairs I, II, III and IV. Each leg is made up of six articles united by joints, and from proximal to distal end are named *coxa*, *trochanter*, *femur*, *tibia*, *protarsus* and *tarsus*. The coxa, is firmly

fixed on the ventral aspect of the body, and may be furnished with one or more spurs; the others are movable. The distal article (tarsus) is furnished at its free end with two claws and on its lower aspect a disc-like membranous expansion (pulvillum), and a cup-shaped organ (Haller's) which has been supposed to be subservient to the sense of hearing.

IXODOIDEA. TICKS.

KEY TO FAMILIES AND GENERA.

Salmon and Stiles give the ticks as a *superfamily*, divided into the two *families* of *Argasidæ* and *Ixodidæ*. They give the following key to the *families*, *subfamilies* and *genera*:

1. Scutum (dorsal plate) absent **Argasidæ**
   Scutum present **Ixodidæ**

Family ARGASIDÆ.

2. Capitulum removed by at least its length from the anterior margin, hidden beneath the body; body rounded anteriorly, without a projecting beak-like prominence; eyes absent. **Argas**
   Capitulum hidden under a projecting beak-like prominence (hood), so close to anterior margin that the tips of the palpi project from under the body and are visible from above; eyes present or absent. **Ornithodorus**

Family IXODIDÆ.

3. Palpi short, sub-triangular, not, or only slightly, longer than broad; Capitulum short; front of body emarginate for insertion of capitulum. **Rhipicephalinæ**
   Palpi longer than broad; capitulum long; point of body straight or emarginate. **Ixodinæ.**

Subfamily RHIPICEPHALINÆ.

4. Second and third palpal articles straight, not drawn out laterally into sharp points; stigmata comma-shaped. **Rhipicephalus**

Second and third palpal articles drawn out laterally into sharp points ; stigmata nearly round.
Margaropus (Boöphilus)

Coxæ I not bidentate ; coxæ IV of normal size ; eyes absent. **Hæmaphysalis**

Coxæ I bidentate in both sexes ; coxæ IV much larger than I to III ; eyes present. **Dermacentor**

Subfamily IXODINÆ.

5. Palpi valvate on median surface in both sexes. **Ixodes**
Palpi claviform, not valvate in male ; legs very long.
Eschatocephalus

Eyes absent ; anal plates absent. **Aponomma**
Eyes present ; anal plates absent. **Amblyomma**
Anal plates present on males. **Hyalomma**

TICKS. KEY TO GENERA AND SPECIES.

Subfamily RHIPICEPHALINÆ.

Subfamily Diagnosis. Ixodidæ : Palpi short, conical, usually longer than the hypostome.

Type Genus. Rhipicephalus.

Genera : *Rhipicephalus*, *Margaropus*, *Hæmaphysalis* and *Dermacentor*.

Genus **Rhipicephalus.**—Eyes distinct, base of capitulum broader than long, hexagonal on dorsal surface, forming at each side a projecting angle. Palpi short, broad ; third article prolonged on its dorsal aspect by a short, retrograde point ; first article by an internal median lobe, occasionally not distinct, and slightly retrograde. Coxæ I with two generally large teeth. Stigmata in the form of a comma, with short tail in female, long tail in male.

Male with two pairs of anal shields (clypei); (1) one pair of large adanal shields, one on each side of the anus, triangular or occasionally rectangular ; (2) one pair of smaller shields external to these.

Female.	*Male.*	*Distribution.*	*Species.*
Scutum white	Scutem black and white	Zanzibar	*R. Pulchellus*
Abdomen with white lines and points		Zanzibar	*R. Perpulcher*
Scutum slightly emarginate in front		Zanzibar	**R. Brevicollis**
Scutum with unequal (large and small) punctations	Punctation distributed regularly	Europe, Asia Africa, Australia, Philippines, Central America	*R. Sanguineus*
Punctations few, linearly arranged	Punctations in young not near margin	Sumatra	*R. Paulopunctatus*
Punctations numerous	Punctations distributed irregularly	Africa	*R. Punctatissimus*
Anal valve bordered with white		Egypt	*R. Rutilus*
Scutum smooth on the margins	Postero-marginal festoons with white border	So. Africa	*R. Copensis*
Scutum rough on entire surface; eyes dark	Postero-marginal festoons of uniform color	So. Africa	*R. Evertsi*
Scutum elongate, sides convergent back of eyes	Palpi short, thick, angular, 2d and 3d segments or articles drawn out laterally into sharp point	United States South	**Margaropus Annulatus, (Boöphilus Bovis, Ripicephalus annulatus).**
Scutum oval, sides not convergent back of eyes, young yellow	Pale brown, transparent	So. Africa	**M. Decoloratus (Blue Tick) (Boöphilus Decoloratus)**
Punctations equal, close together	Punctations fine, covering entire surface	Europe, Africa, West Indies	**R. Bursa**
Punctations unequal, separated	Scutum of young covering entire dorsal surface	Africa	**R. Simus**
	Punctations deep, none on margins nor marginal shields	Nubi	*R. Compositus*
	Marginal groove of shield double	China	*R. Carinatus*
Dorsal shield smaller than in annulatus; labium has 8 rows teeth.	Very chitinous adanal shields; tail; both smaller than in decoloratus	Australia, Porto Rica S. America	**Margaropus Australis.**
Legs and palpi short; tarsi spurred (1 single, others double); stigmate areas, subrotund, small	Four anal shields; posterior border 7 lobed; stigmate areas and spurs as in female	Caucasus	M. Calcaratus
Hypostome with 10 rows of denticles, 5 rows on each half of hypostome	Central, conical chitinous tail; adanal shields dark brown projecting; hairy	Japan, Paraguay	M. Caudatus

Salmon and Stiles separate from the above the forms Annulatus, Decoloratus, Australis, Calcaratus and Caudatus on the strength of the sharp, lateral points on the second and third palpal articles, These constitute the genus Margaropus.

They furnish the following

KEY TO THE SPECIES OF THE GENUS MARGAROPUS (BOÖPHILUS).

Fiery red spot anteriorly in the middle of the back of female; male without tail; number of rows of denticles unknown. West Indian. **Margaropus (Boöphilus, Hæmaphysalis) rosea.**

Hypostome with 10 rows of denticles; male with distinct horny tail. Japan.

Margaropus (Boöphilus Rhipicephalus) Caudatus.

Male with distinct horny tail. S. Africa.

Margaropus (Boöphilus Rhipicephalus) Decoloratus.

Male unknown. A doubtful Buenos Ayres form.

Male with distinct horny tail. Australia, India, Venezuela, Cuba, Porto Rico. **Margaropus (B., Rhipicephalus) Australis.**

N. America form (porose areas of female not united in median line. Southern United States; Mexico.

Margaropus (Boöphilus, Rhipicephalus) Annulatus.

N. African form. **Margaropus (B., Ixodes) Dugesii.**

Caucasus form (porose areas of female united in median line of Capitulum. **Margaropus (B., Rhipicephalus) Calcaratus.**

Genus HÆMAPHYSALIS.

Generic characters: Eyes absent. Base of capitulum rectangular, twice as broad as long. Palpi conical, second article with strong conical lateral basal projection. Stigmal plate circular or in short comma. Anal shields of male absent. Coxæ I not bifid; coxæ IV of normal dimensions in male.

KEY TO SPECIES OF GENUS HÆMAPHYSALIS.

Palpi longer than broad in male especially. United States. *H. Leporis Palustris.*

Scutum not punctate. *H. Rhinolophi.*

Coxæ I without a spine. Tunis *H. Erinacei.*

Scutum much longer than broad, sides nearly straight. Brazil. *H. Sanguinolenta*

Ventral aspect of uniform color. Outer angle of 2d palpal article rounded in male. Europe, Asia, Africa. *H. Punctata.*

Ventral aspect whitish around vulva and anus. Brazil. *H. Cinnaberina.*

Third palpal article with a ventral spine. In male cervical furrows very deep. Asia. *H. Flava.*

Third palpal article without ventral spine, in male and female. New Guinea, Australia. *H. Papuana.*

Third palpal article with dorsal retrograde horn. India. *H. Bispinosa.*

Tarsi I five times as long as broad. In male 3d palpal articles unite to form pincers. *H. Concinna.*

Tarsi I three times as long as broad. *H. Hirudo.*

A sharp spine on every coxa. Palpi longer than broad in male. Madagascar. *H. Elongata.*

Scutum much longer than broad. Palpa in male as broad as long. Africa. **H. Leachi.**

Second palpal article with retrograde prolongation: male and female. Asia. *H. Spinigera.*

Second palpal article without retrograde prolongation. Male has strong spine on coxæ I. Singapore, Borneo, Sumatra. *H. Cornigera.*

Genus DERMACENTOR.

Eyes present. Base of capitulum rectangular, broader than long. Dorso-submedian porous plates present. Palpi short and thick. Stigmal plate comma-shaped, short. Male without anal shields. Coxæ I bidentate in both sexes. Coxæ IV of male much longer than I and III. Scutum usually ornamented.

KEY TO SPECIES OF GENUS DERMACENTOR.

Scutum blackish, without white spots, in male pubescent. Porto Rico. **D. Nitens.**

Scutum nearly as broad as long; second palpal article with dorsal retrograde spine in both sexes. Europe, America, Asia. **. Reticulatus.**

Body oval; hairs few. *D. Electus.*

Body oblong (in male triangular) hairy. *D. Albipictus* (*Variegatus*).

Light spots on scutum (in male symmetrical) with one anterior, large, arrow-shaped. Africa. *D. Rhinocerotis.*

Scutum with 3 spots (female) or 4, symmetrical (male). Congo. *D. Circumguttatus.*

Scutum glabrous in male and palpi extended laterally. Syria. *D. Parvus.*

Subfamily IXODINÆ.

Palpi long, usually about the same length as the hypostome. *Genera: Ixodes, Eschatocephalus, Aponomma, Amblyomma,* and *Hyalomma.*

Genus IXODES.

Eyes absent. Palpi long. Anal groove open, or closed caudad, but tangent to the anus by its anterior concavity. Tarsi without terminal spurs. Male with ventral shields; pregenital shield between genital pore and capitulum; 2 lateral epimeral shields, more or less surrounding the coxæ and stigmata; a genito-anal shield of elongate pentagonal form between genital pore and anus; an anal shield, triangular, ogival, or circular, caudad of preceding, the anterior apex encircling the anus, the base formed by the posterior margin of the body; two adanal quadrangular shields parallel to the anal shield. Scutum leaving an uncovered lateral and posterior margin; postero-marginal festoons absent. Stigmata oval.

Female.—With three dorsal longitudinal posterior grooves on the ventral surface; two long genital groves extending from the vulva and diverging backward, and two anal grooves united in front of the anus, parallel or divergent in back, rarely convergent. Stigmata circular.

KEY TO THE SPECIES OF THE GENUS IXODES.

Female.—Porose areas broader than long and close together. *Male.*—Scutum pubescent. **I. Ricinus.**

Female.—Coxæ I with 2 equal spines. *Male.*—Scutum on barely ½ width of back. S. America. *I. Loricatus.*

Female.—Spine on coxæ I long, on postero-median angle. *Male.*—Tarsi with dorsal protuberance near the tip. **I. Hexagonus.**

Female.—Lateral grooves of scutum slight. Punctations fine. *Male.*—Scutum glabrous. Japan, Amoor. *I. Ovatus.*

Female.—Coxæ I without spine at postero-lateral angle. *Male.*—Anal shield closed caudad. Congo. *I. Rasus.*

Female.—Anal grooves reunited in a point posteriorly. *Male.*—Anal shield nearly closed caudad. Australia, India. *I. Holocyclus.*

Female.—Anal grooves distant posteriorly. *Male.*—Anal shield horse shoe shaped. Africa. *I. Pilosus.*

Male characters omitted in succeeding Ixodes.

Female.—First papal article has strong horn directed forward. S. America. *I. Thoracicus.*

Punctations of scutum unequal, the larger near the margin. *I. Diversifossus.*

Coxæ I with small spine at post. lat. angle. S. America. *I. Frontalis.*

Tarsi with dorsal protuberance. U.S.A.? *I. Dentatus.*

Tarsi without dorsal protuberance. Ecuador. *I. Fosulatus.*

Scutum with unequal punctations the largest near the posterior border. Costa Rica (Felis Pardalis). *I. Affinis.*

Body provided with granulations. Madeira. *I. Obscurus.*

Body without granulations. N. Zealand. *I. Precoxalis.*

Coxæ I with 2 subequal spines. *I. Bifurcatus,*

Coxæ I with 1 long spine. Sumatra. *I. Spinicoxalis.*

Coxæ I smooth. Br. Columbia, Alaska, C. Horn. *I. Putus.*

Coxæ with 2 small posterior tuberosities. N. Zealand. *I. Eudyptidis.*

Spine on coxæ I short, at post. lat. angle. N. Zealand. *I. Intermedius.*

Scutum with lateral grooves. Porose areas triangular. *I. Angustus.*

Scutum much broader than long. Tasmania, Mariana Is. *I. Ornithorhynchi.*

Coxæ I unarmed. Tasmania. *I. Tasmani.*

Coxæ I bicuspid. Sikkim. *I. Lævis.*

Coxæ I with short spine. Africa. *I. Luteus.*

Coxæ I with long spine. Brazil. *I. Spinosus.*

Genus ESCHATOCEPHALUS.

Capitulum long. Palpi pyriform (male), claviform (female). Eyes wanting. Anal groove surrounding anus in front and

opening backward. Stigmata circular in both sexes. Dorsal and ventral irregular chitinous thickenings in the male; striæ or fine parallel grooves in the female. Legs usually long.

Type Species. E. Gracilipes-Vespertilionis.

Genus APONOMMA.

Eyes wanting. Base of capitulum usually pentagonal, the dorso-lateral border very short. Palpi long. *Male* as broad as long, or nearly so; ventral surface naked, sexual grooves very divergent backward, and groove semicircular or ogival, opening in front, uniting the sexual groove; ano-marginal grooves single. Scutum covering entire dorsal surface and usually marked with metallic green spots. Stigmata comma-shaped. *Female* with scutum nearly or quite as broad as long, with usually three metallic green spots in triangle. Ventral grooves as in male. Stigmata shorter, less attenuate at postero-lateral extremity.

KEY TO SPECIES OF GENUS APONOMMA.

Scutum green spots, five in number (male), large, well apart (female). *A. Gervaisi.*

Scutum green spots, nine in number (male); tarsi with spurs (female). *A. Exornatum.*

Scutum channeled by fossettes; body much broader than long (female). *A. Transversale.*

Tarsi II to IV narrowed at extremity (male); spots on scutum few, fine (female). *A. Læve.*

Tarsi II to IV with terminal tuberosity (male). *A. Politum.*

Scutum with light spots (male); tarsi 3 times as long as broad (female). *A. Decorosum.*

Tarsi II to IV narrowed at extremity (male); numerous deep scutum punctations (female). *A. Trachysauri.*

Tarsi II to IV with terminal tuberosity (male). *A. Concolor.*

Tarsi at least 4 times as long as broad (female). *A. Hydrosauri.*

Tarsi without spurs (female). *A. Trimaculatum.*

Genus AMBLYOMMA.

Eyes usually flat, slightly salient, sometimes hemispherical, brilliant, in a submarginal depression of the scutum. Capitulum long, with valvate palpi. Anal groove semi-circular, opening in

front, uniting the sexual grooves; usually no median ano-marginal groove. Scutum often marked with color designs. No anal plates in male. Stigmata usually triangular, with rounded angles. Nearly always eleven posterior marginal festoons, especially in male.

KEY TO SPECIES OF GENUS AMBLYOMMA.

Punctations over whole scutum (male); coxæ I with one very long spine. N. America, Md., Tex. *A. Americanum.*

Punctations lacking from triangular scutal projections, flat, radiating posteriorly (male). Mexico, Cl. and S. America. *A. Cajennense.*

Hypostome with 8 rows of denticles (male). N. America. *A. Multipunctum.*

Hypostome with 8 rows of denticles (male). Nicaragua. *A. Crassipunctatum.*

Hypostome with 6 rows of denticles (male); large median scutal spot, 2d palpal article 3 times as long as 3d. S. America. *A. Calcaratum.*

Hypostome with 6 rows of denticles (male. S. America). *A. Varium.*

Spine of coxæ IV long and strong; body broad (male). Mexico. *A. Cœlebs.*

Spines of coxæ I very long (male). Cl. and S. America. *A. Fossum.*

Spines on coxæ I very short, tuberous (male), III and IV with one tubercle each (female). Cl. and S. America. *A. Scutatum.*

Second palpal article 1½ times as long as broad (male), twice as long as third (female). Scutum without large median spot. Cl. and S. America. *A. Nodosum.*

Punctation on scutal scapular angles large, about 10 (male). Mexico, Cl. and S. America. *A. Sparsum.*

Scutum yellow with brown spots; coxal spines conical (male); coarse punctations about 30, (female). Cl. and S. America. *A. Dissimile.*

Postero-marginal festoons absent (male); two red symmetrical, dorsal, abdominal spots (female). Africa. *A. Hippopotamense.*

Eyes hemispherical, in sockets, (male); scutum triangular, deep brown, (female). Africa, Guadaloupe, Guatemala.
A. Variegatum

Scutum black in anterior third (male). Natal. *A. Annulipes.*

Coxæ I, bilobed (male). Africa. *A. Rugosum.*

Coxæ I with one long spine (male and female).
A. Maculatum.

Coxæ I divide nearly to anterior margin (male). Mexico, Paraguay. *A. Ovale.*

Marginal swellings striated longitudinally (male). Australia.
A Triguttatum.

Anterior spot on scutum, and postero median one separated by transverse band (male); eyes in scutum (female). Africa.
A. Hassalli.

Anterior median spot and posterior median one connected (male); scutum without lateral spots (female). Africa.
A. Splendidum.

Punctations very fine or obselete (male and female) scutum pentagonal (female). Brazil. *A. Concolor.*

Punctations large, unequal (male). S. America. *A. Geayi.*

Punctations of scapular angle very fine (20 male). French Guiana. *A. Paulopunctatum.*

Design on Scutum like H and Y consecutively (male). Scutum spots lateral of cervical grooves (female). Africa.
A. Eburneum.

Transverse band on middle of scutum (male). Africa.
A. Subluteum.

Linear postero-median spot separate from anterior ones (male). Africa. *A. Hebraeum.*

Linear Postero-median spot continuous with anterior ones. Africa. *A. Marmoreum.*

Marginal groove continuous (male). Australia. *A. Moreliæ.*

No (?) antero-lateral light spots (male); coarse punctations scarce (female). Australia. *A. Limbatum.*

Antero-lateral light spots present (male). Africa. *A. Latum.*

Coxæ I with 2 very long spines (male); eyes near middle of length of scutum (female). Brazil. *A. Striatum.*

Coxæ I with 2 short spines (male). Congo. *A. Cuneatum.*

Eye in orbit (male); scutum yellowish white, cordiform. S. Africa. *A. Sylvaticum.*

Coxæ II and III unarmed (male). Africa. *A. Foàì.*

Coxæ IV with 2 short spines (males). Uruguay. *A. Gypsatum.*

Scutum with non-punctate elevations (male). Hypostome with 6 rows of denticles. Mariana Islds., Phillippines (?) *A. Cyprium.*

Scutum level, median field with few punctations. Java. *A. Quadrimaculatum.*

Entire scutum punctate (male); Coxæ III and IV with 2 tubercles each. S. America. *A. Goldii.*

Punctations lacking on parts of scutum; body broad (male); punctations large, deep; eyes toward anterior $\frac{1}{3}$ of scutum (female). Cochin China, Java, Borneo. *A. Testudinarium*

Scutum brown with whitish scapular spots; coxal spines flat (male). Brazil. *A. Humerale.*

Coxæ I with unequal teeth; coxæ II and III unarmed (male). Punctations small, superficial (female). Africa. *A. Thollona.*

Body short oval; scutum variegated (male); scutum large, lateral coppery spots (female). *A. Tuberculatum.*

Body subtriangular; scutum of uniform color (male). Brazil. *A. Fulvum.*

Coxæ I unicuspid; scutum with white spots (male). Cuba, Brazil. *A. Albipictus.*

Coxæ I bicuspid; scutum with metallic spots. Phillippines. *A. Decoratum.*

Scutum smooth (female). Natal. *A. Læve.*

Scutum very large, 5 mm. long (female). S. Africa. *A. Crenatum.*

Scutum much broader than long (female). Congo. *A. Breviscutatum.*

Scutum without spots; punctations confluent in lines (female). Galapagos. *A. Pilosum.*

Eyes extend laterally beyond scutum (female). Singapore. *A. Extraoculatum.*

Coxæ I with 2 sharp spines; coxæ II and IV with 1 tuberosity each (female). Brazil. *A. Parviscutatum.*

Coxæ I with 2 blunt spines; coxæ II and IV, with 2 tuberosities each (female). Guatemala. *A. Sabaneræ.*

Eyes toward anterior third of scutum (female). Bolivia. *A. Vittatum.*

Coxal spines conical, strong (female). Banda Islds. *A. Cordiferum.*

Punctations very fine (female). Siam. *A. Sublaeve.*

Hypostome with 8 rows of denticles; scutum 17 mm. broad. Colombia. *A. Diminutivum.*

Scutum pentagonal; punctations equal. Spain. *A. Dubitatum.*

Hypostome with 8 rows of denticles; coxæ III and IV one tubercle each. Vité Levon Islds. *A. Acutangulatum.*

Scutum cordiform, 5.5 mm. broad; tarsi gradually narrowed. Zanzibar. *A. Aureum.*

Eyes toward anterior fourth of scutum. Africa. *A. Devium.*

Scutum oval, punctations numerous on whole surface. Trinidad. *A. Giganteum.*

Scutum lozenge-shaped, punctations rare in the middle (Nymph). Trinidad. *A. Avicola.*

Genus HYALOMMA.

Eyes present, occasionally hemispherical, brilliant, in a submarginal orbit of the scutum; or flat, scarcely salient. Capitulum long, palpi valvate. Anal groove semi-circular, opening forward, uniting the sexual grooves, and followed by a median ano-marginal groove. Body elongate oval. Color more or less deep brown. *Male:* two pairs ventral shields, adanal and lateral; often two accessory shields behind the latter. Scutum festooned posteriorly. Tarsi with spines. *Female:* Stigmata triangular. Larva and nympha festooned posteriorly.

KEY TO SPECIES OF GENUS HYALOMMA.

Eyes flat; coxæ I not incised; numerous equal scutal punctations; median border adanal shield longer than posterior one. *H. Crassitarsus.*

Numerous unequal scutal punctations; median border adanal shield longer than posterior one. *H. Ægyptium.*

Few, equal scutal punctations; median border adanal shield shorter than posterior one. *H. Affine.*

MARGAROPUS (BOÖPHILUS) ANNULATUS (BOÖPHILUS BOVIS. RHIPICEPHALUS ANNULATUS. IXODES BOVIS. I. DUGESSI. I. PLUMBEUS. I. ALGERIENSIS). TEXAS FEVER (PIROPLASMOSIS) TICK.

Identification with ticks known under other names. Geographical distribution: Southern United States, Southern Europe, N. Africa. Characters of female and male. Six-legged larva. Development: Eggs hatch in three or four weeks in summer, moult and form octopod nymphæ in one week, on calf; moult again, becoming mature in one week more on calf and are fertilized; fertilized female lays eggs in 22 to 26 days. Hosts: cattle, deer, (and less frequently horses), mostly on pubis, perineum, udder and scrotum. Pathogenesis: local irritations; inoculates *piroplasma bigeminum*, causing Texas fever; piroplasma conveyed through ova and next generation of ticks. In localities free from piroplasma, the indigenous tick causes local irritation only.

The same tick appears to have been described under these different names. Neumann further identifies with this species, *Hæmaphysalis Rosea* of the West Indies, the *Hæmaphysalis Micropla* of Italy, the *Rhipicephalus Calcaratus* of the Caucasus, and *Rhipicephalus Annulatus Caudatus* of Japan in spite of the distinctive caudal spur borne by the latter.

The **Margaropus Annalatus** is abundant in our Southern States and was held identical with species found in Southern Europe and North Africa (Cooper Curtice). This is now denied, and at least doubtful.

Female. Body elliptical, broadest in cephalo-thorax, constricted slightly in a transverse direction in the middle near legs IV; when replete, approximating to a parallelogram; when fasting, flattened, coriaceous, narrowed behind, color—from a tawny yellow (young) to an olive green (old), often marbled with irregular waving lines of yellow and black, often a central line of yellow with two marginal lines of black, then two more lines of yellow and two more of black. Dorsal shield (scutum) prominent and convex in the dried specimen, very much shorter in the female than in the male, showing as a dark brownish spot in the anterior end of the median line, and deeply notched to receive the head (capitulum). Two lateral dorsal grooves ending a little behind legs IV. One median groove in posterior part of body. All these grooves vary with muscular contraction and disappear

under repletion. Ventral aspect shows laterally in anterior half four pairs of notches corresponding to the position of the legs. Vulva, small, central, between legs II. Anus between second and last thirds of body. Two lateral sexual grooves. One median anal groove from the anus to posterior margin of body. Stigmal plate small, slightly oval, with scattered granules, and many minute ones. Legs (8) slender, brown, with 6 segments, and each terminated by two hooklets and a sucker. Stiff hairs on all articles. Cuticle of the body finely wrinkled and with short hairs. Head (capitulum) very short. The mandibles, 860μ with internal apophysis bidentate, external apophysis tridentate. The *dart* (hypostome) is flat, spatulate, with four rows of recurved hooklets. The *palpi* are short (310μ), articles (segments) as broad as long, and numbers two and three bear the sharp, pointed, lateral projections which characterize the margaropus.

Male. Body oval, narrowed in front, broadest across stigmata. Dorsal shield (scutum) reddish brown, covers entire dorsal surface, prolonged in front by two pairs of projections, the outer the most prominent, shows three grooves, two lateral and one posterior central. Posterior border festooned, sometimes indistinctly. Large, circular, bristle-bearing spores over the entire surface. Ventral surface lighter colored, hairy, genital orifice central between legs II, anus in posterior third, just back of plane of stigmal plates. Stigmal plates small with 20 or 30 large granules, and many small ones between. Two pairs of anal plates (clypei) elongated anteriorly, one pair near the anus, and one more laterally. No median caudal appendix. Head (capitulum) similar to that of female, somewhat smaller and straighter. Legs relatively larger, and stronger.

Fasting, the mature female averages 6 mm., the male 3.5 mm. Blood gorged, the ovigerous female is about 9 mm. to 12 mm. (½ inch).

Hexapod larva. Body oval, narrowed in front, 600μ long, 470μ broad, yellowish. Scutum covering half the back, scarcely notched for head anteriorly; hairy; stigmata small, round, between legs I and III, behind III and possibly between I and II. Legs very large and strong relatively to the body; tarsi without spurs.

Reproduction. Development. Dr. C. Curtice traced the life history of this parasite. The eggs laid by the ovigerous female hatch out hexapod larvæ in three or four weeks in warm weather (12 to 322 days according to temperature—Schroeder). After one week on a calf these larvæ moult and form octopod nymphæ and young males. After one week more on the calf the nymphæ moult a second time and become sexually mature females. After fertilization the mature female increases slowly for nineteen to twenty-two days, then very rapidly for a few days longer, when she drops off from her host, and in two or three days begins to lay eggs. Each blood-fed female lays on an average 2100 eggs.

Hosts. This tick attacks cattle and deer, and less frequently horses and, it is alleged, sheep. It is found on cattle where the skin is thin and tender, on the inner sides of the thighs and elbows, on the pubis, perineum, udder and scrotum, and less numerously on other parts (ears, neck, ribs, back). When abundant on the pastures, in the comparative absence of cattle, it is found to attack horses, especially about the ears. Placed upon another animal, after its first or second molting, the larva attaches itself and lives out its life to nympha or ovigerous female on such second animal. This is true even if it has been twenty-four hours apart from any mammalian host. Removed from the first, just before the second molting, it continues to molt and can live for two weeks unattached, and then will attack the first bovine animal available. As larva it can be made to attach itself to ox, horse, ass, mule, or cat and develope on its host to maturity. Nymphæ after detachment of two weeks, will attach themselves to man or rabbit, horse or sheep, sucking blood. Can live 322 days without a host. (Schroeder).

Pathogenesis. In all cases these ticks cause local irritation and swelling on their hosts. They open the way for the introduction of many infections, but above all and most important of all, they are the bearers of the *piroplasma bigeminum* which they implant in their bites causing the protozoan cattle fever of our southern states (See Texas Fever, Vol. IV). The natural products of the tick do not cause Texas fever, in districts into which the piroplasma has not penetrated, but wherever, the animals infected with this protozoön are found these ticks are the natural

means of conveying it from animal to animal. The ticks are the more redoubtable that the piroplasma is transmitted through the eggs from the parent tick to the offspring of the next generation.

' An opinion is held that nymphæ and mature ticks don't infect, but only the larvæ. Sudden outbreaks of Texas fever a few days after the arrival of tick-infested cattle appear to contradict this. Probably the rarity of such outbreaks depends on the tenacious hold maintained by the immature ticks (the mature ticks leaving the skin, go at once to laying their ova and it is three or four weeks before the embryos are hatched and advanced to the parasitic—larval—stage). Few immature ticks may be detached, and fewer still may get on susceptible cattle, so that these are immunized rather than killed.

MARGAROPUS (BOÖPHILUS) AUSTRALIS : TEXAS FEVER (PIROPLASMOSIS) TICK OF AUSTRALIA, INDIA, S. AMERICA, PORTO RICO AND CUBA. SCRUB TICK.

Characters of female and male. Dorsal shield smaller, lighter in color, capitulum shorter, mandibles with each apophysis, inner and outer, tridentate, male with central chitinous caudal appendix. Hosts : cattle, deer, horse. Pathogenesis : convey Texas fever to cattle in countries in which the piroplasma is present.

Female.—Like that of *Margaropus Annulatus.* Lateral contraction of the body opposite the stigmata is usually greater ; dorsal shield smaller, lighter in color ; capitulum shorter, mandibles have both apophyses—inner and outer—tridentate, the inner showing a rounded process as well, palpi very short with lateral angular projections as in *M. Annulatus.*

Male. Smaller than *M. Annulatus*, 2.2 mm. long, by 1.3 mm. broad across legs IV. Dorsal shield (scutum) extends the whole length of the body, but leaves a small rim of the lateral margin uncovered. It has two pairs of projections forward from its anterior border, and two pairs on the back, the front pair the more projecting, anterior and lateral being on the plane of limbs I. Two lateral furrows extend to the posterior border, while a median groove shows in the posterior part of the body only. In the

median line the scutum is prolonged backward by a strong conical process (tail), 85 μ long. Dorsum and venter are covered with round pores bearing bristly hairs. Capitulum (head) 425 μ long, mandibles have tridentate internal apophysis and bidentate external apophysis. Dart (hypostome) with 4 rows of teeth on each half. Palpi as in *M. Annulatus*. Legs relatively large and strong.

Hosts. This tick attacks cattle, deer and horses.

Pathogenesis. In lands which they infest, these ticks carry the Texas fever germ (Piroplasma Bigeminum) from ox to ox, as the M. Annulatus does in the United States and Southern Europe. Doubtless they inoculate the same protozoön on deer and horses but there is no evidence that any corresponding disease results.

MARGAROPUS (BOÖPHILUS) DECOLORATUS. TEXAS FEVER (PIROPLASMOSIS) TICK OF S. AFRICA. BLUE TICK. RHIPICEPHALUS DECOLORATUS.

Characters of female and male. Body oval (fasting), dorsal shield transparent, venter yellow, head red, mandible with inner apophysis bicuspid, dart with three rows of teeth, four anal shields, chitinous conical caudal appendix in male. Pathogenesis: transmits Texas fever in piroplasma districts in S. Africa. Doubtful species. Other rhipicephali.

Female. Body of young and fasting oval, sides convex, posterior half scarcely broader than anterior, 2.2 mm. long, by 1.3 mm. broad; when replete 10 to 12 mm. long, by 6 to 8 mm. broad; color slaty blue; dorsal shield (scutum) longer than broad; punctations very fine, brilliant, yellow in median portion, red on the sides; eyes red; scutum in mature yellow in centre, red at the margins; lateral grooves at first converging, then diverging to the postero-lateral borders; scutum in young semi-transparent allowing the dark intestinal organs to shine through. Venter yellowish with dark spots shining through. Anus reddish. Head (capitulum) red, mandibles with inner apophysis bicuspid, and one rounded process; dart (hypostome) with 3 rows of teeth on each side. Legs yellow or red, tarsus with 2 hooklets, and one short sucker; coxæ I with 2 short denticles.

Male. Pale or dark brown semi-transparent. Dart with six rows of teeth, 3 on each side. Four anal shields, more chitinous than in M. Annulatus, and ending posteriorly in points. Abdomen ends in a strong, chitinous, conical caudal appendix.

Pathogenesis. This transmits protozoan hæmaglobinuria among cattle in S. Africa as the Annulatus and Australis do in other parts of the world. It abounds in many regions in S. Africa to which the piroplasma has not penetrated and its mere presence there does not determine that disease.

DOUBTFUL SPECIES.

In the list of Margaropus have been entered **M.** (*Rhipicephalus*) **Calcaratus** of Caucasus, which Neumann considers as identical with *M. Annulatus* of the United States:—the **M.** (*Rhipicephalus*) **Caudatus** which the same author identifies with *Rh. Microplus* from Paraguay (our *M. Australis*);—and the **Hæmaphysalis Rosea** of the W. Indies, which both Curtis and Neumann consider to be identical with *M. Annulatus.* With our present knowledge therefore any special description of these may well be omitted. An uncertain species from Japan alleged to have 5 rows of denticles on each side of the dart (hypostome) may also be held for further demonstration.

Rhipicephalus texanus. *Female.* Red-brown, legs pale, no markings; capitulum broad, lateral angles acute; palpi short; porose areas on posterior part of capitulum, triangular; shield longer than broad, rounded behind; legs slender, long tarsi, coxæ I with two spines behind; stigmal plate pearshaped, finely granulate (goblet cells). *Male*, red-brown; capitulum twice as broad as length of palpi; palpi very short, tips acute; dorsal shield long and narrow with lateral grooves extending back from the eyes; seven festoons without basal grooves; legs long; coxæ I with two processes behind (like Dermacentor); elongate triangular plate each side the anus; stigmal plate elongate slightly narrowing behind, finely granulate (goblet cells). Abundant on dogs and horses in Texas, New and Old Mexico.

OTHER RHIPICEPHALI.

Other species of the genus *Rhipicephalus* are chargeable with the local irritations caused by ticks generally, but the transference

of specific infections of other kinds, is less common. In common, however, with blood sucking or biting insects, when in great numbers in presence of a pathogenic blood or skin parasite and its animal victim they may easily contribute to the diffusion of epizoötics.

HÆMAPHYSALIS.

Bearer of protozoön of paludism in dog in S. Africa. Dorsal shield much longer than broad, teeth on lower surface of dart in five rows on each side. *H. Leporis palustris*, infests the hare.

H. Leachi. This deserves record as the bearer of the protozoön of paludism of the dog in S. Africa. It has the dorsal shield much longer than broad (female), the dorsal surface of the palpus at least as broad as long (male), and the teeth on the lower surface of the dart (hypostome) in five rows on each side.

H. Leporis Palustris. Swamp-hare H. is an American species which attacks these wild rodents and (the larva) birds but is not reported as a pest of the larger animals. It has the palpi longer than broad in both sexes, and the denticles on the lower surface of the dart (hypostome) in two rows on each side.

Female. Red-brown to black on shield, capitulum and legs; capitulum longer than broad, rostrum with a spine at each hind angle below; palpi with spine on outer side at base, third joint with lamellar ridge extending over hypostome, second joint hairy; porose areas elongate, separated by more than their breadth; shield longer than broad, punctate, with large, deep submedian grooves; legs slender, coxæ I bifid behind; abdomen striate, punctate; stigmal plate subtriangular, as broad as long, with closely packed large goblet cells. *Male.* Paler; palpi shorter; body twice as long as broad; distinct lateral grooves; eleven festoons, without basal furrow. It is found from Dannemora, N. Y. to the Gulf of Mexico, and on both Atlantic and Pacific slopes.

Hæmaphysalis Cordeilis. *Female.*—Shield, legs and palpi reddish-brown, abdomen yellowish-brown; capitulum twice as broad as long; palpi broad, second joint with hook on outer side at base; porose areas large with marginal ridge on each side; shield as broad as long, punctate most densely at the sub-

median grooves ; legs short ; coxæ with posterior projection on coxæ I half as wide as the joint ; abdomen striate with broad deep punctures ; stigmal plate elongate, with dorsal projection and finely granulate (goblet cells). Found on turkey, night-hawk, etc., in New England.

DERMACENTOR.

Dermacentor Reticulatus: retrossal hooklet on dorsal aspect of second palpal article. Body flat, narrowed toward the head, scutum white or irridescent rose or green. Punctations and hair pores give a netted aspect, young female, male. Geographical distribution : Europe, Asia, America (California, N. Mexico, Texas). Hosts : man, ox, horse, deer, sheep, rhinoceros. *D. Variegatus:* scutum deeper brown, thinner covering of silver rust. Probably variety of *reticulatus*. *D. Electus:* body almost hairless, stigmata punctate. Characters, male, female. Distribution : United States, Atlantic and Pacific slopes. Hosts : Dog, man, horse, rabbit, antelope, panther, etc.

D. Reticulatus. Net Dermacentor. This is distinguished from other species of Dermacentor by the presence of a retrograde process on the dorsal aspect of the second palpal article.

Young Female. Body flat ; oval, more narrowed toward head ; 5 mm. long, by 2.5 mm. broad ; reddish-brown behind scutum ; dorsal shield (scutum) milk or silver white or irridescent rose or green extends back to opposite legs III, with elliptical outline, notched in front for head (capitulum). Eyes pale brown, a little in front of the middle of the lateral margin. Two marginal grooves from behind the eyes backward ; three grooves from the scutum backward, one median and two lateral. Posterior border divided into eleven festoons, enlarging laterally. Punctations and hair bearing pores give a general reticulated appearance to both dorsum and venter. Genital pore opposite legs II ; anus at beginning of posterior quarter of body. Stigmal plate comma-shaped. Head (capitulum) 750μ long ; mandibles with digit having internal apophysis bearing one recurved tooth, and external apophysis bearing three increasing in size from the terminal one back. Dart (hypostome) with recurved denticles in four rows in front and three rows posteriorly (Neumann), (according to Stiles the fourth row is unreal consisting of the hooklets of the mandibles

showing outside the dart). Palpi longer than the dart with ventro-internal hairs and the second article bearing the characteristic blunt retrograde dorsal point. Legs of moderate length, hairy; coxæ I bidentate, II to IV with spur on posterior margin; tarsi II to IV have strong, recurved terminal spine.

Ovigerous Female. Body turgid, nearly as broad in front as behind, constricted laterally opposite the two small dorsal stigmata, color deep brown (slaty), legs brown (black in alcohol). Dorsal shield with thin silvery white metallic rust shading to rose or green. Grooves shallow or effaced, punctations slight or absent, surface glabrous. May be 16 mm. long by 10 mm. broad.

Male. Body as in young female. Dorsal shield reddish brown with a white silvery metallic rust shading to rose or green, in front a large elliptical spot with white border, then a second spot with radiating white lines, then three more, a median rounded and two lateral rather semi-circular spots. A marginal groove limiting eleven posterior marginal festoons with white and brown markings. Punctations present on the entire surface. Venter as in young female. Stigmata somewhat comma-shaped. Mandibles have internal apophysis transversely elongated, bidentate, external apophysis also bidentate with terminal tooth the smaller. Dart (hypostome) has three rows of teeth on each side. Palpi longer. recurved point on second article prominent. Coxæ encrease in size from I to IV the last being very large. Tarsi II and III with two spines each; three spines on each of coxæ, femur, tibia and protarsus, on the ventral surface.

Geographical Distribution. This tick is found over wide areas in Europe and Asia. Has not been found in the United States.

Hosts. Dermacentor Reticulatus attacks man, cattle, horses, deer, roe-deer, fallow-deer, sheep and rhinoceros, and probably other animals, producing great irritation. It may convey infection but has not been incriminated in connection with Texas Fever.

Dermacentor albipictus (variegatus). *Female.* Capitulum, palpi and legs white above, reddish or yellowish brown beneath; shield long, mostly white with median and two lateral streaks and spots near eyes, red brown and few puncta; capitulum broad, hind angles extended; porose areas large and set

near together; palpi very short and broad; abdomen elongate with parallel margins; legs long, coxæ spined; stigmal plate large, subtriangular, narrower in front and with many large granules (goblet cells). *Male.* White above with pattern of brown spots and lines; shield elongate, punctate; legs large especially IV; stigmal plate elongate with many large granules. *Male* 4 mm. long. Female shield 2.2 mm. Found in Adirondacks, New York, Mich., Nebr., Mont., Ida., Nev., Wash. and Canada, on Moose, Wapiti and other deer. Will probably attack cattle.

Dermacentor parumapertus. *Female.* Shield dark red, legs slightly paler, no white markings, save exceptionally a few small spots on body and joints of legs; capitulum broad; palpi very short; porose areas small, circular, well apart; shield longer than broad, deeply punctate; legs small, short coxæ spined; stigmal plate small, subtriangular, with large granules (goblet cells) dense in outer part. *Male.* General characters of female, with no white on shield, porose areas or stigmal plate; the latter is elongate, and narrowed behind, with large densely packed granules in front around stigma, and small ones behind. *Male* 2.8 mm. long. *Female* shield 1.1 mm. Found on man, and in chicken house in California.

Dermacentor parumapertus var. marginatus. In this variety the female has the shield bordered with white, the porose areas are larger and closer together, the lateral lobes of the shield have fewer puncta, the stigmal plate has its dorsal prolongation narrower than in the *parumapertus*. Found on jack rabbits at Mesa City, Arizona.

Dermacentor Venustus. *Female.* Capitulum and legs reddish brown with white spots on the tips of joints; shield largely white with fewer brown spots than *Occidentalis*. Abdomen red-brown; capitulum broad with posterior angles little prominent; porose areas large, oval, close together, palpi short. Shield as broad as long with small puncta; legs of medium size, coxæ armed, stigmal plate ovoid with narrow dorsal prolongation, bearing finer granules than on the main body of the plate. *Male.* Color features as in female; shield much longer than broad (5.3), finely punctate, lateral grooves; legs moderate; coxæ armed; Stigmal plate smaller and with narrower dorsal process than in the female. *Male.* 3.5 to 5 mm. long. *Female.* Shield 2 mm. long.

Found in Olympia, Yakima, Klikitat Valley, and Grand Coulee, Wash., Bozeman, Mont., Soldier, Idaho, Bridge Basin, Utah, Ft. Collins and Boulder, Col., Pecos and Las Cruces, N. Mex. and Texas, on man, sheep and other animals. Is charged with diseminating spotted fever in Montana.

Dermacentor occidentalis. *Female.* Shield red-brown, mostly covered with white waxy bloom, white spots on tips of joints; legs paler on dorsum; capitulum small with prominent hind angles; porose areas very small and close together; shield as broad as long, slightly pointed behind in the median line, finely punctate; legs small; coxæ armed; stigmal plate with broad dorsal extension, having large granules (goblet cells) in the body and small ones in the extension. *Male.* Similar color markings as in female, red-brown showing most on the eyes, the puncta, the ventral aspects of the legs, and the festoons; capitulum narrow, hind angles spinate; palpi very short; shield elonggate, (1.5 to 1), finely punctate; distinct lateral furrows with twelve indented lines behind, legs moderate in size, tarsus IV with denticles, two large and one small, other joints denticulated, coxæ armed, IV extra wide at the base; stigmal plate elongate, with broad turned up dorsal extension. *Male.* 3 to 3.5 mm. long. *Female,* shield 1.5 mm. Found on deer and other animals in California, Occidental, San Diego, Goose Lake, etc.

Dermacentor Nigrolineatus. *Female.* Shield, legs and abdomen red-brown, without white markings; capitulum nearly twice as broad as long, hind angles extended; large oval porose areas; palpi short; shield longer than broad, breadth greatest before the middle, pointed behind, sparsely punctate; legs small and short; coxæ armed; stigmal plate oval with large densely packed granulations (goblet cells). *Male.* Paler red-brown; capitulum with elongate posterior angles (spiniform); shield elongate (1.7 to 1), punctate toward the margins, hairy; festoons slight, separated by twelve lines. *Male.* 3.5 mm. long. *Female.* Shield 1.2 mm long. Largely found on deer in Adirondacks, Catskills, Texas and Wisconsin.

Dermacentor Variabilis. *Female.* Red-brown color with white margins and tip on shield, on joints, in two dorsal lines, and around eyes; Capitulum broader than long (2 to 1), posterior angles nonprominent; porose areas oval and well apart;

palpi short, broad ; shield longer than broad, broadest in middle, punctures sparse in middle area, four form trapezium behind ; legs large, long, spines on lower side and coxæ ; stigmal plate large, broad behind, finely granulate (goblet cells). *Male.* Same characters, white spots in two lateral dorsal stripes, on joints, and borders of festoons ; capitulum broader than long (2 to 1); palpi long ; shield elongate (1.5 to 1), punctate in lateral and posterior parts ; legs large and denticulated especially IV ; coxæ armed ; stigmal plate large, broad with small dorsal prolongation, granules (goblet cells) dense, small. *Male.* 4 mm. *Female.* Shield 2 mm. Common from Labrador to Texas on dogs and cattle, but also attacks other mammals including man.

Dermacentor Nitens. *Female.* Red-brown, no white markings, legs palest, abdomen darkest ; capitulum, moderate width, hind angles not very pronounced ; porose areas large, apart, well forward ; palpi very short ; shield slightly longer than broad, breadth greatest in front of middle, finely punctate, marginal wrinkles in front and on sides ; legs long ; denticles on coxæ short ; stigmal plate large, circular, with about ten to twenty large isolated granules (goblet cells). *Male.* Same general characters ; palpi short ; shield elongate (1.7 to 1), broadest just behind middle, punctate toward front and sides, three grooves on posterior part, and two lateral lines ; coxæ with two short denticles, IV with one ; stigmal plate nearly round with four to ten very large granules. Found in Hayti, San Domingo, Jamaica, Texas, and Arizona. From the very short palpi (seen also in Margaropus) Nathan Banks suspects a habit connected with the dissemination of disease.

Dermacentor Electus. Dog Tick. This differs from D. Reticulatus in that the body is nearly hairless and the stigmata are punctate.

Female. Dorsal shield elongate from before backward, somewhat lozenge-shaped, with notch on anterior angle for head, leaving two projecting lateral points. Dorsum almost glabrous. Head about 1.5 mm.; dart (hypostome) with three rows on each side of short broad denticles. Stigmal plates comma-shaped to elongated oval, bear the characteristic punctations. Ovigerous female may be 15 mm. long, by 9 mm. broad.

Male. The rust on the dorsal shield is whiter, the colors and spots are variable, but the punctations of the comma-shaped or oval stigmata are characteristic (Stiles).

Distribution. This tick is very common in forests and uncultivated lands east, and even west, of the Rocky Mountains. While it has taken its name from its common victim, the dog, it freely attacks man, horse, rabbit, antelope, panther, etc. It causes much irritation and even anæmia and may easily become the bearer of infection from animal to animal.

IXODES.

Ixodes Ricinus: Variegated color like castor oil bean,—black, brown, yellow; external mandibular apophysis with five teeth (7 or 8 in male) increasing backward; dart has teeth increasing in size backward. *Distribution:* Europe, N. Africa, America. *Hosts:* Sheep, cattle, goats, horses, deer, hare, rabbit, dog, cat, fox, ferret, hedgehog, bat, bird, man, etc. Probably conveys *louping-ill. I. Hexagonus, I. Reduvius*: Size and form of I. Ricinus; dart with three rows of teeth on each side, the median largest though less numerous, shorter legs than ricinus, venter hairy.

Ixodes Ricinus. *Castor-bean Tick.* This familiar tick has been named in accordance with the form, size and variegated color, which strongly suggest the bean of the castor oil plant (Ricinus Communis).

Female. When replete (ovigerous) may be 10 to 11 mm. by 6 to 7 mm., ash colored with marbling of black, brown or yellow. Dorsal shield deep brownish chestnut, oval, subpentagonal, lateral borders salient, posterior angle rounded, anterior slightly notched for head, punctations small, uniform and regularly distributed, hairs numerous, fine and short. Two anterior grooves divergent posteriorly; three posterior grooves, median and two lateral, the latter concave centrad. Genital pore on plane of legs IV. Anus with three hairs on each lip. Stigmal plate finely punctate, pore small. Mandibles rough (shagreened) on sheath of stem, internal apophysis elongate with two retrograde teeth (median and terminal); external apophysis with five teeth encreasing in size from the anterior to the posterior one. Dart (hypostome) lanceolate, with three rows of teeth on each side. Legs thin and

bearing stiff hairs on each article. Coxæ I bears a strong spine on the postero-median angle. Tarsi long and thin, in I nearly one-third of the leg.

Male. Body oval, deep reddish-brown. Dorsal shield covers entire dorsum except a thin marginal zone ; punctations very fine and numerous. Genital pore opposite legs III. Pregenital shield a third longer than broad, narrower, round or sinuous anteriorly, convex laterally. Head (capitulum) 500 μ long. Mandibles corrugated transversely on the sheath, internal apophysis with three teeth—the median the largest, external apophysis with seven or eight teeth encreasing in size from before backward. Dart (hypostome) has teeth encreasing in size from before backward. Legs larger and stronger than in female.

Distribution. Europe, N. Africa, America ; common, well known.

Attacks sheep, cattle, goats, horses, deer, hare, rabbits, dogs, cats, fox, ferret, hedgehog, bats, birds, man, etc. This is a great pest of the dog, and is credited with transferring from sheep to sheep the microbe of Louping-ill, and from ox to ox, in Europe, the germ of Texas fever. There can be little doubt that it stands ready to convey to fresh victims the germ of any disease of the blood or even of the skin, from and to any of the large class of animals on which it preys.

Ixodes Hexagonus. Dog Tick, (*Europe*). **I Reduvius.** *Female.* Size and shape of Ixodes Ricinus ; Dorsal shield more lozenge-shaped with lateral angles sharper, posterior angle narrower, punctations larger, genital pore between first intercoxal spaces. Anus just behind the limit of posterior third of the body. Grooves united in arch in front and divergent to posterior border of the body. Dart (hypostome) with three rows of teeth on each side, the median the largest but only three or four in number and anteriorly. Palpi shorter than the mandibles, the third article almost as long as the second. Legs relatively shorter and thicker than ricinus, coxæ I with short retrograde tooth, tarsi large, thick, short, bulging toward the extremity, with a convex ridge.

Male. Body elliptical, nearly as broad anteriorly as posteriorly, brownish red, with lighter colored legs. Dorsal shield covers whole dorsum except a thin marginal zone of a lighter color,

with numerous hair-bearing puncta. Genital pore between level of legs II and III. Pregenital shield broader than long, narrower behind than in front. Anal shield ogival in front, divergent behind. Almost twice as long as broad. Epimeral plates strengthened laterally by chitinous plates and marked toward inner side by pits bearing hairs. Whole venter bears fine hairs. Anus as in female. Mandibles and dart bear teeth like those of ricinus. Legs relatively longer and stronger than in female, coxæ approach each other in the same pair ; retrograde spine of legs I a little less strong than in ricinus.

Distribution. Europe and United States.

Attacks dogs, cattle, sheep, hares, rabbits, gophers, squirrels, porcupines, cats, men, birds, etc. Like I. Ricinus it is alleged to be generally harmless yet in large numbers it must be relatively injurious, and may become the bearer and inoculator of infections. In Russia it is believed to transmit the piroplasma of Texas Fever. (Beinaroyich).

Ixodes Californicus differs from I Ricinus by greater breadth of capitulum ; shield yellow, brown, slightly longer than broad, trapezoidal ; porose areas subtriangular, broader than long with oblique inner edge ; abdomen striate, punctate and hairy ; ventral grooves diverge behind ; stigmal plate round, small, finely granulate. Female 1.2 mm. Male 2 mm.

Found on gray fox and black tailed deer in California.

Ixodes Scapularis. *Female.* Shield dark red brown, longer than broad ; legs and palpi paler ; abdomen brown ; capitulum broad ; porose areas only slightly smaller than in *ricinus*, much broader than long and separated by more than their length ; outer angle not far from hind angle of capitulum ; legs long, slender, hairy below, with long tarsi ; coxæ with long sharp spine at the base behind and apical tooth, unarmed ; stigmal plate circular, finely and evenly granulate ; ventral grooves diverge behind. *Male* dark red-brown ; palpi very short ; shield with subparallel sides, very hairy and punctate ; stigmal plate large, elongate. Size as in *I. ricinus*. Common in Southern States and as far north as Indiana on man, dog, cattle and sheep.

Ixodes Dentatus. *Female.* Shield, capitulum and legs dark red-brown, abdomen almost black ; rostrum small, prominent on posterior angles and on the under side a stout recurved

tooth on each side; shield a little longer than broad; the middle area behind finely punctate; abdomen (engorged) elongate, striate and punctate, with many very short hairs; stigmal plate round, minutely granulate, stigma central; Coxæ I and II with a long basal spine behind. Found on rabbit in Maryland.

Ixodes Cookei. *Female.* Shield and legs yellow-brown, legs the paler, abdomen gray-brown; capitulum broad, triangular hind angles moderately prominent; palpi short and broad; porose plates one fourth broader than long and half their diameter apart; shield slightly longer than broad, narrowed behind, coarsely punctate; abdomen punctate, with very short hairs, gorged specimens elongate; anal grooves subparallel behind; stigmal plate, large, eliptical, and granulate, stigma in front of center; coxa I with long stout spine at base; legs large and long. *Male.* Yellow-brown; very short palpi; shield more than twice as long as broad, rounded behind, densely punctate, has three shallow grooves, the two lateral ones extending further forward; stigmal plate large and formed as in the female; coxæ with spines having sharper points. Common in eastern states from Maine to the Rockies; attacks man, dog and feral mammals (fox, mink, weasel, skunk, pocket and striped gophers, porcupine, woodchuck, racoon) and robin.

AMBLYOMMA.

General characters: *A. Americana*: Scutum reddish brown, with white or metallic green spot in posterior angle; 11 post. festoons. Distribution: N. and S. America. Hosts: Cattle, sheep, other animals, man. Ticks of uncertain genera: I. Scapulatus; I. Marmorata; I. Erinaceous; I. Marginata; I. Chelifer; I. Camelinus; I. Rugica; I. Rotundus. *Destruction of ticks*: Lighter mineral oils; oils of turpentine or tar; bland oils; hot knife-blade or wire; oil baths; remove brush and stock; rotation of crops; divide pasture in two and pasture each in alternate years. Exclude wild animals.

These have eyes flat, or slightly salient, brilliant, sometimes hemispherical, in a submarginal depression of the dorsal shield. Anal groove semi-circular, opening forward, sexual grooves unite at this point. Median ano-marginal groove rare. No anal plates in the male. Dorsal shield often marked with designs in color.

Stigmata usually triangular with rounded angles. Nearly always 11 posterior marginal festoons.

Amblyomma Americanum. Lone Star Tick. *I. Americanus. Young Female.* Body oval, longer than male (4.5 mm. long by 3 mm. broad). Dorsal shield triangular in its posterior two-thirds, posterior angle open and rounded; reddish brown with a white or metallic greenish yellow spot in the posterior angle giving name to the species. Cervical grooves deep anteriorly, shallow and open behind; punctations numerous, small, equal, regularly distributed. Eyes nearly marginal, toward anterior third, large, flat, yellow to white. Eleven posterior marginal festoons limited in front by a deep groove. Surface rough, puckered, shagreened. Hairs sparse and fine. Genital pore median between legs I to II. Stigmata whitish, broad, triangular, finely punctate, pore small on elongated ridge. Head (capitulum) 1.1 to 1.5 mm. long, base longer than in the male, and shows porous areas. Palpi straight, second article relatively long. Legs long and thin with long hairs; spine of coxæ IV very short, scale-like; tarsi long (I more than four times, IV four times as long as broad).

Ovigerous Female may be 12 mm. long by 8 mm. broad.

Male. Body oval, much broader posteriorly; brownish red, lighter on the marginal ridge; 3 to 3.5 mm. long by 2.5 mm. broad. Dorsal shield slightly convex; cervical grooves shallow, more so backward; marginal groove narrow, beginning close to the edge just back of the eye and gradually widening, in front of the 11 festoons, to the median line behind. Often two light-colored spots (silvery, golden or green) postero-internally to the eyes; others appear postero-laterally close to the marginal groove and still others on the festoons. Eyes large, flat, yellow to white just behind legs I. Venter ochre-yellow with fine sparse hairs; intestines may show as dark sinuous lines; genital pore between limbs II and III; anus slightly in front of the posterior quarter of the body. Stigmata large, whitish, comma-shaped; with pore small and anteriorly situated. Mandibles with external apophysis bidentate. Dart (hypostome) with three rows of teeth on each side, the median rows close together. Palpi long, thin, the second article twice as long as the third. Legs moderate size; coxæ I with two spines, the outer one the longer; coxæ II and III

have each a short broad spine on the posterior border ; coxæ IV have each one long strong spine. Tarsi I four times as long as broad, and II to IV three times as long as broad, have each two claws ; pulvillum half as long as the hooks.

Distribution. The tick has a wide distribution in North and South America attacking cattle especially, but not sparing other animals, nor even man. It may very well become a means of transferring infections, but has not been incriminated in the case of the protozoan fever of cattle.

Amblyomma maculatum. *Female.* Shield brown in front, silvery white behind and toward borders, the white of the middle extends forward in two streaks with a more or less perfect median brown stripe ; pentagonal, broader before the middle, punctate laterally ; abdomen very dark, hairless ; capitulum long, hind angles barely acute ; porose areas, widely separated ; palpi short ; legs large, tarsi slender, Metatarsi II, III and IV with a pair of spurs at the tip ; coxæ I with sharp spine, II, III and IV with tubercle ; stigmal plate long, with dorsal extension, and small granules. *Male.* Shield brown with 3 pairs of silvery white lines more or less connected ; isolated white spots on the strongly marked festoons ; dorsum with deep furrows ; legs large especially IV, white spots on joints, II, III and IV with two large spurs on tip of metatarsus ; coxæ I and IV with sharp spine ; stigmal plate long with tapering upturned tip and minute granules (goblet cells). *Male* 4 mm. long. *Female* shield 2 mm. Found in Texas, Louisiana, Tennesee, Florida, Virginia and California, on cattle, dogs, horses, foxes, and men.

Amblyomma Cajennense. *Female.* Yellowish, capitulum darker on margin, shield mostly silvery with white brown on margins from eyes back ; capitulum broader than long, hind angles acute ; porose areas circular, widely separated, palpi slender ; shield pentagonal, broader than long ; densely punctate ; legs slender with white spots on joints ; coxæ I with two spines, IV with smaller spine, II and III with tubercles. Stigmal plates subtriangular, broadest behind and finely granulate. *Male.* Pale or brownish yellow, with lateral silvery streaks and brown or redish brown spots ; capitulum subtriangular, hind angles rounded ; palpi with middle article much longer than distal ; body broadest behind the middle, punctate, with median streak

and four spots on each side, smooth ; festoons twice as long as broad ; legs slender, tarsi long, IV with three denticles below ; coxæ I two spined, IV single spine, II and III tuberculated. Stigmal plate long, slender, densely but finely granulate. *Male*, 2.7 mm. long. *Female* shield 1.8 mm. Found on a great variety of animals in tropical and subtropical America, S. America, Cl. America, W. Indies, Mexico, Florida, Texas, Arizona, California, etc. Not common on cattle or horses.

TICKS OF UNCERTAIN GENERA.

I. Scapulatus. Epauletted Tick. A common tick in the woods of Europe and America, distinguished from the *I. Reduvius* by the shorter rostrum, and by the presence at its base of two additional organs folded like a fan.

I. Marmorata is distinguished from the *I. Reduvius* by a slightly shorter rostrum, and by a more graceful thoracic escutcheon with symmetrical brown spots on a lighter yellowish brown ground. It attacks mammals, and its presence on sheep in *louping-ill* districts, has led to the charge of carrying the germ of that disease.

I. Erinaceous and **I. Marginatus,** white or light colored ticks varying slightly from *I. Marmorata*, have also been found on sheep suffering from *louping-ill* and are therefore suspected.

I. Chelifer. Pincer Tick. This differs from *I. Reduvius* in having the third article of the palpi curved inward and pointed so that with its fellow it appears like pincers.

I. CAMELINUS found on camels in the Steppes of Asia, and I. RUGICA and I. ROTUNDATUS found in South America need not be more than mentioned as having been found on domestic animals.

Destruction of Ticks. It is easy to kill the tick on the skin by a drop of naphtha, benzine, gasoline, kerosene, oil of turpentine, oil of tar, or other insecticide. A drop of oil closes the breathing stigmata and kills the insect. A hot knife blade or wire applied on the tick causes it to loosen its hold and drop off. In extracting the tick mechanically it is said to be most easily accomplished by turning it to the left as in extracting a screw. For destroying the ticks upon stock a mixture of oil and some parasiticide (kerosene, cresol, sulphur) is usually employed. A

bath with an inclined plane at each end for the animal to walk in and out, and deep enough to submerge the animal is filled with water on which is floated a mixture (10:1) of crude cottonseed oil, and refined petroleum oil. In walking through, the animal gets a uniform coating of the oily mixture which is destructive to the tick. Another method is to bring the oily mixture through a hose from a barrel placed at a higher level and allow it to flow upon and smear the skin, especially on the ventral aspect and inside the different limbs, the parts most infested by the ticks. To clear a range of ticks, one of the most effective measures is to remove all brush and rank vegetation, even grass tufts, in which the insect may find shelter. A rotation of cultivated crops for a series of years will be still better. Cattle having the range of infested wood lots, should be excluded from other pastures during the warm season. Finally in the case of ticks which attack but one or two species of animals, they may usually be exterminated by dividing the pasture into halves by a double fence and pasturing these on alternate years. On the half which is used for hay the ovigerous female ticks fail to get their supply of blood and fail to produce any eggs or any large number of eggs. For ticks that attack a large number of vertebrate animals of different genera this method would be useless, as wild animals cannot be wholly excluded from the field. From single cattle the ticks may be picked off in clear daylight and the legs, sides and especially the axillæ and groins smeared with the kerosene, sulphur mixture (kerosene 1 gallon, cotton seed oil 1 gallon, sulphur 1 lb.). Repeat often. By picketing single cattle on tick free pasture after dressing they can be preserved from further infestment.

ARGASIDÆ.

Flat body ; no dorsal shield ; head under cephalo-thorax ; usually eyeless ; largely venomous. *Argas Miniatus :* Like bed-bug ; attacks at night, driving sitting birds from nests ; fasting, has wrinkled or shagreened skin with rows of pits. Distribution : S. United States, especially in nests of hens and turkeys, also on ox. Causes anæmia, wasting and death. *A. Reflexa :* A. of pigeons ; dart with two rows of teeth on each side. Distribution : France, Italy, in dove cots. Attack young and old ; man may suffer. Cause anæmia and wasting. Reproduction apart from having animal host. Treat-

ment. *A. Persicus:* Attacks pigeons and men. *A. Tholozani:* Persian sheep-tick; venomous. *A. Fischeri: A. Mauritianus: A. Hermanni*, in Egypt; *A. Moubata*, in Angola; *A. Talaje*, in Tropical America.

With a flat body without scutum; the head (capitulum) is concealed beneath the cephalo-thorax and in common with the hæmaphysalis they are usually destitute of eyes. They are blood-thirsty and often venomous.

Argas Miniatus. Chicken Tick. Argas Americanus. This tick looks like a bed-bug, like which it has nocturnal habits, nourishing itself by sucking the blood of mammals and birds, living in the nests of the latter, killing the sitting birds or driving them to forsake their eggs.

In both sexes when fasting the skin is wrinkled or shagreened and bears very fine, short hairs; on the margins, dorsally and ventrally, are quadrangular bodies bearing short hairs; they show beside numerous glistening pits mostly in rows radiating from the centre of the body and usually symmetrical on the two sides. Anus about the middle of the venter with 6 or 8 short bristles on each side. Stigmata outside coxæ IV, crescentic with concavity postero-internally. Genital pore large, between coxæ I and II. Coxæ of legs I to IV crowded together on antero-lateral part of venter and very far forward. Tarsus becomes suddenly attenuated near the end especially in I, giving a hunch-backed appearance. Legs bear many stout bristles and especially the tarsi.

Female. May be 11 mm. long by 8.5 mm. broad. Mandibles with internal apophysis transverse and pointed at both ends, middle apophysis with terminal tooth turned outward, external apophysis with two teeth at base and at apex respectively.

Dart (hypostome) bears at its apex on each side 4 small terminal teeth, then 6 large teeth in two vertical rows so that they appear in pairs, then a series of medium sized teeth, three abreast, in transverse rows. Palpi bear 4 strong bristly hairs each.

Male. May be 4 to 8 mm. long, by 2.5 to 5 mm. broad. Dart and mandibles as in female. Palpi one-sixth longer than mandibles. Genital pore narrower than head (in the female is as broad as head.)

Larvæ. These are small and round (diameter about 700 μ) or broader from side to side. Capitulum (head) shows more in

front of the anterior margin of the body than in mature. Legs relatively long, (II shortest) stout and covered with penniform hairs. Palpi 258 μ long, fourth article longest (100 μ).

Distribution. This tick is found in the Southern United States, largely on chickens but also attacking turkeys and other birds. It has been once found on cattle. As a night prowler it renders the nest intolerable for the sitting bird and often drives it to abandon its eggs. Otherwise it produces great anæmia and wasting, and not infrequently destroys life.

Argas Brevipes. Size and general characters as in Miniatus. Legs much shorter and smaller with tibia enlarged at distal end. Fewer smooth spots on dorsum—three pairs on anterior part of body with a row of four on each side of them, others are irregular in distribution. Found at Tucson, Ariz., in hole in Cereus giganteus probably used by a bird.

Argas Reflexus. A. Marginata. Rynchoprion Columbæ. The Argas of Pigeons. Head (capitulum) 1 mm. with rounded point. Dart (hypostome) with two rows of recurved teeth on each side of the median line with the beginning of a third row near the end. The fecundated female is 5 mm., by 3 mm. fasting, or 6 mm. by 4 mm. after gorging. The male is smaller, and brown. Is more ovoid than miniatus.

This is common in pigeon houses in France and Italy, attacking the pigeons on the neck, chest, wings and other parts of the body especially of the young, producing anæmia, emaciation and death. In the older pigeons they may drive hatching birds from their nests and prevent encrease. Found in our southern states (Osborn) and in Mass. (Wright, Banks).

Men and particularly children often suffer, and when the dovecots adjoin human dwellings the latter are invaded and the inmates attacked. The feet and hands are mostly attacked and though the resulting wound may be but a red point without areole, yet the whole limb may become the seat of intense itching up to the shoulder or buttocks.

They are very tenacious of life, living for 22 months without food (Ghiliani), and they reproduce their kind even when deprived of the blood of animals (Boschulte).

Treatment must proceed on the same lines as for ixodes, and they should be driven from the dove cots by thorough cleanliness, washes of mercuric chloride, painting with tar water, etc.

Argas Persicus. The venomous bug of Miana, lives in beds and is said to be fatal to strangers sleeping in them. Megnin doubts this, having seen them bite pigeons frequently without material harm.

Argas Tholozani, the *Kene* or sheep tick of Persia has a similar reputation.

Argas Fischeri has been found in Egypt, **Argas Mauritianus** in Mauritius, **Argas Hermanni** in Egypt, **Argas Moubata** in Angola, **Argas Talaje Argas Chinche** and **Argas Coriaceus** in Tropical America.

The precautions to be taken against Argas are like those recommended for ixodes.

ORNITHODORUS.

Like argas and eyeless. Body oval, lateral border often straight or concave, anterior border curved ventrally over head, mammillated hemispherical elevations on skin. *O. Megnini: Spinose ear-tick:* Body lyre-shaped elongated, rounded ends, broadest in front of median constriction; brown, violet or black; mandibles slender, internal apophysis with four teeth, external with three; dart unarmed; eyeless. Dart has teeth in larva and nympha. Distribution: Mexico, N. Mexico, California, Kansas, Nebraska, Texas. Hosts: Ears of Equines, ox, and other animals; attacks man. Pathogenesis: in meatus causes irritation, head-shaking, rubbing, nervous disorders. *Treatment:* Fill meatus with bland oil, and crush argas as it emerges. *O. Turicata: Mexican mite:* Attacks pigs, all domestic animals including birds and man; very poisonous; may kill pig in a night. *O. Egyptius.* Distribution: Egypt, Senegal, Guadaloupe,—giant tick, 1 inch. Hosts: equines, ox, carrying poison of so called *farcy* in cattle. (See Vol. IV, 296).

This is a genus of the Argasidæ, presenting the general characters of this family even as a rule to the absence of eyes. The body is oval or with straight, sometimes even concave lateral borders, and posterior border rounded. Anterior border curved ventrally to form a cover for the head. Tegument mammillated with hemispherical elevations; depressions on dorsum; venter showing two longitudinal folds opposite coxæ; two transverse furrows respectively in front of and behind the anus, and a median groove from the anus to the post-anal furrow.

Ornithodorus Megnini. The Spinose Ear Tick. Garrapata. Body lyre-shaped, nearly twice as long as broad, rounded at both ends, slightly constricted just behind its middle, and broader in front of this. Color, brown to violet or black. On dorsum two grooves, starting from behind the head, arch backward near the lateral margin often showing interruptions, and a median groove extends over nearly all the posterior narrowed part of the body. On the ventral surface there is no pre-anal groove, but the post-anal groove turns forward on the two sides to join the grooves along the inner borders of the coxæ. This coxal groove passes between coxæ one and two. Stigmata large, circular with a semilunar pore. Anus near posterior border bearing fine hairs on its lips. Head (capitulum) very short and narrow (150 μ long); mandibles slender, internal apophysis bearing four teeth, external apophysis with three teeth. Dart (hypostome) blade-shaped, unarmed. Palpi longer than other head organs with many pennate hairs on base near palpal insertion. Legs moderate in size, prominent tuberosity on dorsal surface of each tarsus. Eyes wanting. Females 5 to 6 mm. long, by 3 to 4 mm. broad; males somewhat less.

In nymph and larva the hypostome (dart) is armed with teeth which Megnin also figures in the adult though Stiles and Neumann failed to find them. In these young forms the skin is finely striated and pierced with symmetrically arranged pores from which project spines in the anterior part of the body and bristle-like hairs in the posterior. Stiles describes a pupa-like resting stage between the hexapod larva and octopod nymph. The nymph is better armed and may grow as large as the adult.

Distribution. Dugés first described this argas in Mexico, and it is common in adjacent states (California, Idaho, New Mexico, Nebraska, Kansas, Iowa, Kentucky, Louisiana, Texas).

Hosts. It is particularly common on the ears of horse, ass, mule, cattle, and other animals, and even attacks the human being. It is not confined to the concha but invades the auditory meatus as well, and gives rise to much irritation, shaking and rubbing of the head, and even to nervous and other disorders and, it is alleged, death.

Treatment. They can be made to vacate the external meatus by filling it with olive or other bland oil, and should be inter-

cepted and crushed as they emerge. Megnin believes that this parasite did great damage to the French army horses in Mexico during the reign of Maximillian.

Ornithodorus Turicata. Mexican or Central American Mite. Carrapata. Turicata. This is common in Central America, Mexico, Columbia, California, Arizona, N. Mexico, Florida, attacking the axilla or groin of pigs and other domestic animals and not even respecting man. Pigs put into infested pens may perish in a single night, death being preceded by general weakness and loss of control over the limbs. An areola of swelling and ecchymotic effusion surrounds each puncture to the distance of one or two inches. The bites in man often cause serious lesions. Hens eating the argas, for but a single day, become dull, lose appetite, and perish in three days (Megnin).

Ornithodorus Egyptius (**Savignyi**). This is common in Egypt and Northern Africa. It is a very large tick, the unfecundated female being 9 mm. and the fecundated as much as 25 mm. (1 inch) in length. It is characterized by the presence of three hooks on each chelicer (mandible) and by three rows of recurved teeth on the barb, in place of four as in *Margaropus Annulatus*. According to Neumann it is the giant tick of Senegal and Guadaloupe. It attacks horses, mules and cattle producing a local infectious disease known as "*farcy*" (Nocard). This is another example of the conveyance of infection by ticks as in Texas Fever and Louping-ill. (See Farcy in Cattle Vol. IV).

Ornithodorus talaje. Talaxi. Body conoid in front, broad and rounded behind. Dorsum with a broad groove on each side, united in front, and diverging behind. Venter with two lateral oblique grooves; a median groove from anus backward; with rough granules, enlarging toward the margins. Rostrum retractile, usually hidden under the margin of the body. Palpi short, last article slender and turned backward, Legs short, slender, hairy; tibiæ and metatarsi as long as broad. *Female* 5 to 6 mm.

These have been found in Guatemala, California, Texas and Florida. They attack man and animals producing a very painful sore.

Ornithodorus Coriaceus. Color brown, darker than the talaje; legs lighter. Conoid in front in median part widens

more rapidly than talaje, sides subparallel, constricted slightly behind legs III. Brown surface dotted with small yellow granules on venter most marked in posterior half. Groove from anus backward, and two lateral grooves a little longer. Eye behind leg I, and smaller one behind leg II. Rostrum in depression, nearly hidden. Depressed areas without granules on dorsum. Legs long and slender, I, II and III with prominent tubercles above, and a few hairs. Replete female 7 to 8 mm. Attacks men and cattle in Mexico and California.

GAMASIDÆ. POULTRY ACARIASIS.

Free filiform palpi; abundant in fodders: *Gamasus Pteroptoides:* In fur of small rodents; harmless. *G. Auris:* In external auditory canal of ox. *Dermanyssus Gallinæ: D. Avium:* Flattened, piriform, broadest behind. Habitat: hen and pigeon manure, cracks in woodwork, or masonry. Nocturnal attacks on birds, mammals, man—*Poultry Acariasis.* Itching, rubbing, scratching, pecking, biting, depilation, abrasion, excoriation, scabbing, anæmia, loss of weight; in nasal chambers, cause catarrh; in meatus, otorrhœa. *D. Hirundinis:* Double the size of D. Gallinæ. *Treatment:* Clean away manure, scald, whitewash, carbon bisulphide, creolin, oil of tar, etc.; dust baths with lime, sulphur, insect powder, snuff, etc. In acariasis of nose or ear, olive oil.

These are acarina with free filiform palpi.

Gamasus Pteroptoides found in the fur of field mice, moles and rabbits is characterized by a small rostrum, styliform mandibles, large limbs, equal in the two sexes, and terminated by claws and caruncle. About 0.5 mm. long. They live on the exudations and do not appear to be hurtful.

Gamasus Auris found by Turnbull in great numbers in the external auditory canal of the ox as deeply as the tympanic membrane, is supposed to have been a wanderer from forage in which the gamasidæ are largely represented.

Dermanyssus Gallinæ. D. Avium. This is pyriform, broadest behind, flattened from above downward, hairy, yellowish white when fasting (among manure), blood-red when gorged (on skin), female 0.7 mm.; male 0.6 mm. long.

Habitat. Pathogenesis. During the day these are found in neglected and filthy hen houses, poultry yards, dove cots, etc., among the manure, and in cracks and fissures in the wall, floor

and perches, also in the nests. At night they become extremely active getting upon the birds and sucking their blood, banishing sleep, causing anæmia, emaciation and weakness, and even driving the sitting birds from their nests : **Dermanyssus Acariasis.** In the same way they make nightly attacks on horses, cattle and other animals kept in the same buildings with the fowls or near to them : **Poultry Acariasis : Poultry Lousiness.** This leads to intense itching, rubbing, loss of hair, and the formation of abrasions, sores, scurfy productions and scabs, the cause of which may not be apparent. Enquiry will show that they live near fowls, and a visit after nightfall will reveal the presence on the skin of myriads of the blood sucking dermanyssus. Human beings, who frequent the poultry houses are attacked, also those that pluck the fowls, or handle the feathers or manure. Usually they cause in man but a temporary pruritus, unless the exposure continues day after day. Goldsmith, however, cites the case of a woman with a chronic skin disease, on whose skin the acarina appeared on the surface during perspiration, but retired into the cutaneous gland ducts in the intervals.

Poultry Otacariasis and Rhinacariasis. Zurn and Webber have found this dermanyssus colonized in the nasal chambers of poultry and pigeons causing an acute nasal catarrh, and Lax has found them in the external auditory meatus of chickens causing otorrhœa.

Among other animals attacked are the rabbit (Gurlt), goat (Farez), the dog and cat (Zurn). Swallows often suffer, but the dermanyssus of swallow's nests has been assigned to a different species (**D. Hirundinis**) mainly because it is double the size. Megnin describes the *D. Avium* as intermediate in size between those of the hen and swallow. The phœbe nest often swarms with D. Avium.

Treatment of Dermanyssus Acariasis. The same measures recommended for *phthiriasis* are effective here ; remove all droppings ; keep the house perfectly clean ; deluge the woodwork with boiling water or treat with live steam ; whitewash ; wash with carbon bisulphide, creolin, coal tar, sublimate lotion, etc. Dust the nests with insect powder, quicklime or other insecticide. Furnish dust baths containing snuff, lime, insect powder, carbolic acid, creolin, etc.

Exposed mammals may be treated with the same agents mixed with oil, and should be kept well apart from filthy hen roosts.

Fowls suffering from the acarian rhinitis or otorrhœa should be *treated* freely with olive oil introduced on a small feather or brush. This is destructive to the parasite by closing its breathing pores, and is soothing to the irritated integument.

TROMBIDIIDÆ: HARVEST MITES. ACARI OF QUILLS.

Soft, hairy skin, bright color, larvæ burrow in skin. *Trombidium Holosericium:* Scarlet, just visible to naked eye, common in sunny, sheltered localities on vegetation; larvæ burrow under cuticle in man, rodent, dog, cat, horse, ox, sheep, birds, etc.; cause intolerable itching. *T. Americanum:* Dull brick-red, larva attacks men and animals. In sheltered, sunny localities south and west in United States. *T. Fulliginosum:* Smoky color, found in Europe. Has same habits as the others. *Bete rouge* of Central and S. America; *Colorado* of Cuba; *Niaibi* of New Grenada; *Mouqui* of Para; *Ciron Rutilant* of Savannah. *Treatment:* Wear leather boots; apply to skin solutions of tobacco, sulphur, phenol, potassium sulphide, avoid exposure to vegetation of infested places. *Cheyletus of Rabbit:* hexagonal, yellow. Lives in fur, feeding on the listrophorus and other parasites. *Cheyletus of Birds:* Lozenge-shaped, yellow, smaller than rabbits'. Lives in feathers; harmless. *Harpirhynchus Nidulans: Nesting H.:* Lives among quills and on skin forming wart-like clusters; distends quills. *Syringophilus Bipectinatus:* Live in quills; harmless. *Tetrarhynchus Molestissimus.*

This family is characterized by soft hairy integuments, bright color, rostrum as a conical sucker formed by the coalesence of the maxillæ with the lower labium, a pair of delicate styliform chelifera, exceptionally hooked inward, palpi in six segments, the fifth bearing a hooklet.

Trombidium Holosericeum. Silky T. Harvest Mite. Red Beast. Bright scarlet color, abdomen almost square, narrowed behind, notched in the median line, eyes pediculated, body downy, belly and feet bristly. Length of mature 1.35 mm.; of larva 0.4 mm.

This is a widespread species in Europe found especially in warm sheltered localities, gardens, orchards, etc., where it lives on the vegetation. The mature insect is harmless but the hexapod larva gets on the skin of man and beast, burrowing under

the epidermis and causing papular (red) elevations accompanied by intense itching. In man they prefer the clothed surface, where clothing is tight (under suspenders, belts, garters), and in animals the feet, limbs and, in the case of the herbivora, the muzzle especially suffer. They are common on the small rodents, dogs, cats, horses, cattle, sheep and birds and probably no domestic animal is entirely immune from them. The name *harvest mite* implies that they are especially troublesome late in the season, but much depends on latitude as in Southern Europe and in sheltered warm situations they may appear early in July. Their late appearance is to be partly attributed to the necessity for the production of a new brood of larva which alone prove predaceous. They are often found singly or in clusters around the root of a hair or at the opening of a sweat gland and they may avail of such openings to penetrate the skin.

Trombidium Americana. Jigger. In the Southern and Western United States and in warm localities in the middle and northern a trombidium differing from the European in its dull, brick-red color, attacks animals and men in the same manner, producing similar symptoms. It is familiarly known as the *jigger*, having been confounded with the *chigoe sarcopsylla*, the burrowing flea of the West Indies.

Trombidium Fuliginosum. Megnin adduces the smoky trombidium as occurring in Europe and attacking mammals in company with the scarlet, silky species.

The **Tlalsahuate** of Mexico, the **Bete Rouge**, (red-beast) of Guiana, Antilles and Honduras, the **Colorado** of Cuba, the **Niaibe** of New Granada, the **Mouqui** of Para the **Ciron Rutilant** of Savannah, etc., are indetermined species with similar habits to those of the described varieties, and in some cases perhaps identical.

Treatment. In infested regions and seasons men passing through green vegetation seek to protect themselves by wearing tall leather boots, or by rubbing the skin with tobacco water, sulphur, sulphur ointment, or even solution of phenol (1:50). The safest course is to avoid exposure in infested vegetation. These burrowing mites do not survive over two or three days, so that staying indoors for that length of time will effect a cure.

Benzine, oil, glycerine, tobacco, phenol, sulphur, etc., applied to the skin, will, however, destroy those remaining on the surface and do much to ward off a new invasion. To animals the same agents may be applied by way of both prevention and cure.

CHEYLETUS PARASITIVORAX. CHEYLETUS OF THE RABBIT. Is a soft-skin species of the trombidiidæ .30 to .45 mm. long, hexagonal, yellow, with a rostrum one-fourth the size of the body, and palpi one-third the size of the rostrum, in three segments the second furnished with a long hook extending as far as the end of the last. It lives in the fur of *rabbits* and according to Megnin is commensal, destroying the *listrophorus* and other soft skinned parasites of its host.

CHEYLETUS HETEROPALPUS. CHEYLETUS OF BIRDS. Body lozenge shaped, yellow, rostrum a narrow pointed cone, palpi and hook on 2d segment smaller than in the parasitovorax, length 3 to 3.5 mm. They live in the feathers of pigeons and various other birds and do no perceptible harm.

Harpirhynchus Nidulans. *Nesting H.* This species with square or ovoid, flattened body, resembles a sarcoptes in form and rostrum. It lives among the quills of pigeons, parrots and small birds, collecting on the skin in wart like clusters, also in the follicles of the feathers distending them abnormally.

Syringophilus (Pecobia) Bipectinatus. Quill loving mite and **S. (P.) Uncinatus** an elongated mite, live in the interior of the quills of hens, pigeons and other birds without appreciably impairing health.

Tetranychus Molestissimus (or **T. Silvestrii**). **Bicho Colorado.** A large red mite allied to the trombidium and like it living on green leaves of alfalfa preys also on horses and cattle in the Argentine Republic and Uruguay. It is especially severe around the eyes. It takes its name from the four large, strong hooklets on the tarsi. It demands similar precautions with the trombidium.

SARCOPTIDÆ.

General characters: Body white, soft, eyeless, two pairs of legs near rostrum, and two from postero-lateral part of the body, tarsi one-hooked; larva hexapod. Divisions of Sarcoptidæ. Genera of Sarcoptidæ Plumicola.

This family of mites comprises those producing ordinary forms of *scabies*, *scab*, or *mange*, and possess the following common characters: Body white or reddish, 0.1 to 1 mm. in diameter, soft in the normal larva, nympha and adult, (some hypopial nymphæ in certain genera coriaceous); without eyes; respiratory apparatus invisible or incomplete; rostrum formed by the union of jaws, lip and tonguelet, and concave internally; mandibles short, claw-like; palpi with three segments; legs with five segments, two pairs being attached near the rostrum and two pairs to the back part of the body; tarsi with one (rarely more) terminal hook and caruncle or bell-shaped sucker. Oviparous. Larvæ hexapods. Megnin divides the sarcoptidæ into the following five groups:

1. **Sarcoptidæ Detricola** are never parasitic but live on decomposing animal and vegetable matters.

2. **Sarcoptidæ Plumicola** which live in the feathers of birds on cutaneous secretions and do not harm the skin.

3. **Sarcoptidæ Cysticola** which live in the connective tissue or air cavities of birds and only injure mechanically.

4. **Sarcoptidæ Gliricola** which live among the hair or fur of rodents and do not injure the skin.

5. **Sarcoptidæ Psorica** which bite or burrow in the skin, and even at times poison it, causing congestion, itching, abrasion, depilation, and resulting disorder.

The *first group* does not interest us, seeing that its members only get on animals by accident, and temporarily, and are harmless.

The *second group* is equally harmless, but as it lives in or among the feathers it might be mistaken for psoric acari.

The genera of this second group are tabulated as follows by Megnin:

SARCOPTIDÆ PLUMICOLA.

Females resemble the males, but without copulatory bursæ *Dermoglyphus.*

- Females differ from the males which have all copulatory bursæ.
  - Adult females have abdomen always rounded and bristly.
    - Abdomen of male has bristles or scales; third pair of legs never very large.
      - Legs similar and subequal in the two sexes, and bear suckers ..... *Pterolichus.*
      - Four anterior limbs marginal; four posterior, short, subabdominal ..... *Freyana.*
      - Limbs all marginal; third pair slightly larger ..... *Pteronyssus.*
    - Abdomen of males rounded or lobulated and bristly; third pair of limbs larger; fourth pair small.
      - Abdomen round. *Analges.*
      - Abdomen lobulated ..... *Dermaleichus.*
  - Adult females have abdomen lobulated carrying scales and bristles.
    - Abdomen of male shortened and bearing a pair of foliaceous appendices. *Proctophyllode.*
    - Abdomen of male shortened and bearing appendices as bristles. *Pterodectes.*
    - Abdomen of male lobulated and bearing bristles ..... *Pterophagus.*

SARCOPTIDÆ CAVICOLA.

Cystodites Nudus: Body smooth, hairless, longer than broad, viviparous, larval stage transient; live five or six days in the dead tissues. Habitat: in bronchia, air sacs, lungs, air cavities of the bones (intestines), of gallinaceæ. Cochin cocks suffered most, in wet weather. Lesions: Congested mucosa, mites in yellow gelatinous masses and false membranes; in bowels, enteritis, (alleged in kidney, liver, etc.) *Symptoms:* A small number may prove harmless, many, cause inflammation, exudation, dyspnœa, anæmia, wasting diarrhœa, dullness, drooping, feebleness; plumage dull, lifeless, dirty, draggled; comb pale in weak, cyanotic in plethoric. Duration, a few days to months. *Prevention:* Raise new flock from eggs, in incubators, on fresh, sound ground; sacrifice the old, burn or boil carcases, disinfect (mercuric chloride 1:500) houses and runs. Burn manure, sweepings. *Treatment:* A few drops of solution of napthalin, camphor or asafœtida into the trachea every second day.

ACARIASIS OF THE LUNGS AND AIR SACS OF BIRDS.

Cytodites Nudus. (*Kytos* a cavity, *Nudus* naked.) **Cytoleichus Sarcoptoides,** (Megnin). The body is smooth, devoid, or nearly so, of bristles, ovoid with its transverse diameter the

smaller. The rostrum is short, thick, conical, with rounded end and hollowed out so as to form a sucking tube. The eight legs, are moderately long and each formed of five segments, the terminal one ending in a sucker. The male is .45 mm. long, the female .56 mm. Viviparous. The hexapod larvæ are rarely seen as they speedily pass through their first moulting and appear with eight legs. Their life outside the avian body is very little known. They survive 5 or 6 days in the dead tissues or 8 days in a normal salt solution.

Habitat. The cytodites is found in the lungs, bronchia, air sacs, and less frequently in the air cavities of the bones, and still less so in the intestines of chickens, and other gallinaceæ.

The breeding cocks suffered most in the cases of W. L. Williams, and the Asiatic more than other breeds. The disease prevailed mostly in rainy months, in spring and autumn.

Lesions. In the air sacs they may be detected with the naked eye and still more readily with a magnifying lens in yellow gelatinous masses and false membranes. In the bronchia they are associated with a mucopurulent catarrhal product. Gerlach and Zundel have each found them in the intestines in connection with enteritis, Holzendorff found them in the liver, kidneys and other solid organs multiple yellow miliary nodules containing acari, which were however probably the *symplectoptes* of the connective tissue.

Symptoms. When very numerous in the bronchia they cause obstruction, cough, dyspnœa and even asphyxia. Apart from this, Megnin pronounces them harmless, and he denies the possibility of harm owing to the absence of mandibles, hooklets, bristles and other possible sources of irritation. Gerlach and Zundel, on the other hand, claim that they cause extensive enteritis and peritonitis, while W. L. Williams claims to have found serious disorder and anæmia in birds in which the only observable cause was the great abundance of the cytodites. Diarrhœa was the most constant symptom, with thin yellowish white, granular, glutinous fæces which matted the feathers around the anus. The bird was dull, drooping and feeble, in spite of a good appetite, or even considerable remaining fat; the plumage was dull, lustreless, dirty and draggled. Driving caused dyspnœa and gaping. The comb and wattles were pale

and anæmic in the impoverished birds and dark blue or cyanotic in the plethoric or well conditioned.

Duration. The course of the disease varies, some dying early and suddenly of asphyxia, while others survived three or four days or weeks, or even months, according to the number of acari, the strength of the patient or the organs attacked.

Prevention. Treatment. The disease is difficult to deal with because apparently sound birds may harbor the acarus, and spread it to the whole flock though themselves unsuspected. Hence it is usually desirable to sacrifice the entire flock, maintaining the breed by setting their eggs in an incubator or under a healthy hen from outside, and raising the chicks in poultry houses and yards that are above suspicion of contamination. The carcases should be burned or boiled, and the houses and runs thoroughly cleansed, drenched with boiling water, and then thoroughly sprayed with corrosive sublimate solution (1:500), or other insecticide. They should be left unoccupied for at least three months, or more safely (considering the tenacity of life of many larval acari) until the following season. The hen manure, litter and sweepings of the houses and yards must be burned or disposed of safely in places to which no other birds have access.

For the *treatment* of the diseased birds nothing satisfactory has been proposed. Sprinkling of the floor or smearing of the feathers of the neck with camphor, asafœtida, napthalin or other volatile insecticide may be tried, or one of these agents in solution may be cautiously injected into the larynx and trachea and repeated daily or every second day. This can only be hoped to affect the acari in the air-passages and sacs, and the bird must be still treated as dangerous and excluded from sound flocks, houses and runs.

Symplectoptes Cysticola. Laminosioptes Gallinarum. (Megnin). Acarus of the Connective Tissue of Birds.

Connective tissue acarus: Body more than twice as long as broad, with median transverse furrow; eight legs, very short, thick. Habitat: Connective tissue, gallinaceæ, on skin in epidermic concretions; death of acarus causes calcified miliary nodule. When present in great numbers, cause numerous caseous centres, anæmia, wasting. *Treatment:* Unsatisfactory; best to raise new flock from the eggs on fresh ground.

Body oblong, more than twice as long as broad, gray, several pairs of dorsal and ventral bristles and one long pair on the posterior extremity, rostrum short and thick as in the sarcoptes; a transverse furrow separates the anterior from the posterior part of the body, and the skin has fine transverse striæ. The eight legs are very short and thick, the two posterior ones terminated by suckers. Male 20 mm. long; female 25 mm.

Habitat. These have been found in large numbers in the connective tissue, especially the subcutaneous, in the gallinaceæ (hens, pheasants, turkeys). Rivolta has found them abundantly on the surface and in the substance of the skin causing dandruff and squama. From this they are supposed to extend into the loose connective tissue in the neck, chest, belly, flanks and thighs. When one acarus dies it causes a miliary nodule which tends to early calcification, and hence miliary cretifactions are common lesions in this affection. The live acari are sometimes present in large numbers in plump, vigorous fowls, yet Rivolta has noted an advancing marasmus in those that were badly infested and that had numerous caesous centres in the skin, subcutaneous tissues, muscles and abdomen. Old and wasted birds suffer most.

Treatment is very troublesome and unsatisfactory. The ordinary acaricides may be used to destroy the mites in the skin, the buildings, roosts, nests, and yards should be thoroughly cleansed and treated with the same class of agents, and all affected birds should be removed from the general stock. The raising of a new flock, from eggs set in incubators, and on fresh uncontaminated ground will prove the most effectual measure.

SARCOPTIDA GLIRICOLA: LISTROPHORINÆ.

General habits: Live on detritus in fur of rodents. *Listrophorus Gibbosus:* Lips form pincers; live on rabbits and hares. *L. Mustelæ:* On head, neck and shoulders of ferret, etc. *L. Leuckarti:* Very long; on field mice, partridges, etc. *Myocoptes Musculinus:* On nose of mouse and rat; harmless.

Common on rodents these are exceptionally found on other mammals, and might be mistaken for psoric acari. They are not known to injure their hosts but merely live among the fur, and feed on detritus.

Listrophorus Gibbosus. Lips forming pincers, to seize the hair. Dorsum convex, rounded. Male with long, bifid, flat, posterior projection. Length 0.5 mm. Common on rabbits and hares.

Listrophorus Mustelæ. Acarus of weasel. The plate of the cephalothorax in two movable pieces. Male notched posteriorly, without caudal projection. Length male 0.4 mm.; female 0.45 mm. to 0.5 mm. This has been found on the head and anterior part of the body of the ferret and polecat.

Listrophorus Leuckarti. Much longer than the above acarus, this has been found by Pagenstecher and Megnin on field mice, partridges and related birds.

Myocoptes Musculinus (mus mouse, copto I cut). Body small, flat, narrowed in front, with very short rostrum; third pair of legs in the male and the fourth also in the female enlarged, flattened and curved to firmly grasp the hairs. Found on the nose of mouse and rat, and harmless.

SARCOPTIDÆ PSORICA.

Acari of Scabies: Flattened body, symmetrically striated; legs, two front pairs near the head; two posterior near back border. Legs bear bell-shaped sucker, posterior ones often long hairs only. Male orifice between two last limbs with chitinous plates, and two lateral suckers to fasten on female. Female orifice just above posterior border. Oviparous: Eggs hatch in one to ten days; larva, nympha, mature, ovigerous. *Fecundity:* New generation of 50 in 15 days; about 730,000,000 from one pair in three months. *Vitality:* Least in Sarcoptes, greatest in Symbiotes, and especially in Psoroptes. Divisions: Sarcoptes, burrowing acari; psoroptes, surface acari on body; symbiotes, surface acari on limbs. List of psoric sarcoptidæ.

These stand apart from the other acari mainly in their tendency to cause a dermatitis accompanied by intolerable itching from which the various names of the affections have been derived: Greek, Pso I rub; Latin, Scabere to scratch; Italian, rogna, raspa; Spanish, sarna, rona; German, kratze; French, gale; English, ich, scab, scald, mange (manger to eat).

They have the common characters of a flattened body, symmetrically striated, with dermic plates (plastrons). The feet are furnished with cushions or bell shaped suckers. The four pos-

terior limbs differ from the anterior, and in the females, nymphæ and larvæ, and in some cases in the males, the cushions are replaced by long hairs. Megnin further credits them with a venomous saliva which serves to produce itching and dermatitis. The rostrum of variable size in different species, is conical and mobile, formed of maxillæ and labiæ united and two chelicera and one lancet shaped tonguelet free. The male organs, between the two last limbs show a number of chitinous plates, and two lateral symmetrical suckers which fix on the body of the female. The vulvo-anal slit on or just above the posterior border, enlarges greatly about the period of breeding. The male has four testicles, two on each side, the excretory ducts of which join in a single canal in the penis. The female has but one ovary and oviduct ending in a cloaca. They are oviparous, the eggs hatching out in from 3 to 10 days, or in favorable conditions in 24 hours. The metamorphoses are the same as in other acari :

1. **Larva.** Hexapod ; asexual ; small ; it passes through two or three moultings becoming on each occasion a simple cellular mass in which, as in an impregnated ovum, the elements of the new being are developed.

2. **Nympha.** In the last moulting a fourth pair of legs is developed, but no sexual organs, the males and females being distinguished by their smaller and larger size.

3. **Mature Male and Female.** From the moulting, which terminates the stage of nympha, the acari emerge with distinct male and female sexual organs. Copulation takes place, the male perishes, and the female passes through another moulting and becomes the ovigerous female.

4. **The Ovigerous Female.** This shows a sub-thoracic vulva, one or more eggs seen through its usually transparent body, and changes in the third or fourth pair of legs, or both.

Fecundity. Encrease. The fecundity is remarkable. Gudden found 51 empty egg shells in a single sarcoptes gallery, and Walz, Hertwig and Gerlach determined that a new generation of sarcoptes hominis succeeded the old and gained maturity in 15 days. Placing the egg product of a single female at 15, Gerlach estimated the natural encrease to be 1,500,000 in ninety days. Noticing that a few seconds contact of a sound horse with a mangy one caused in about 10 or 12 days the development of

myriads of acari on the former, Megnin estimates the encrease of the sarcoptes of the horse as follows ;

	Females.	*Males.*
1st generation after 10 days	30	5
2d " " 20 "	900	50
3d " " 30 "	27,000	500
4th " " 40 "	810,000	5,000
5th " " 50 "	24,300,000	50,000
6th " " 60 "	729,000,000	500,000

Vitality. Gerlach made some interesting experiments to determine the vital tenacity of psoric acari. He found that all the sarcoptes died in an hour in a dry heat of 145° Fah. The *sarcoptes equi* died in 5 to 6 days when placed with its crusts in a show glass, or from 12 to 14 days if placed in an inhabited stable. On a piece of skin covered with crusts and exposed to a very moderate temperature, they died in 9 days, on the drying of the skin ; but if the skin were kept humid the acarus showed signs of life on the 24th day but none on the 28th. The *psoroptes equi* lived 10 to 14 days in a dry atmosphere and 20 to 30 in a stable. Though torpid and apparently dead, the acarus, revived after 6 or 8 weeks when subjected to moist warmth. The *symbiotes* lived in their crusts in a dry warm room for 10 to 12 days, and though after this they were apparently dead, they revived after 14 days under the influence of moist warmth. In spring, in a non-heated chamber they lived 40 days and in a stable not less than 50.

Divisions and Habits of Psoric Acari. The acari which cause the common forms of scabies are naturally divided into the **Sarcoptes** (sarx flesh, coptein to cut) which burrow, forming galleries under the epidermis ; the **psoroptes** (psora itch, ptessein to conceal) which live on the surface in the shelter of hair, scurf and scab, and tend to spread over the whole body ; and the **symbiotes** (sym with, bios life) which also live on the surface sheltering under hair, scales and scabs and attack especially the hind feet and legs.

Sarcoptes are distinguished by round or slightly oval body ; short rostrum and legs, the last pair being concealed beneath the abdomen or nearly so ; the tarsus has often a sucker ; the male is devoid of abdominal bosses and copulatory suckers.

Each gnaws its way into the epidermis and constructs its own gallery, the galleries of the larger females being much more spacious than those of the males. The union of the sexes takes place in these chambers, the males leaving their own burrows to seek the females and being therefore sometimes caught on the surface. The site of the gallery is marked in delicate white skins (man, sheep, etc.) by a fine red line, but this is not observable in the horse or ox. It may be straight, curved or crooked, broken at intervals by a minute vesicle and its outlet is marked by a papule or vesicle, which is especially marked when the larvæ burrow in the delicate, soft, young epidermis at this point. In the gallery of a female are usually found eggs, empty shells and larvæ. The burrowing habit of the sarcoptes makes them the most inveterate of the psoric acari as they cannot be readily reached by local dressings to the skin.

Psoroptes (*Dermatodectes : Dermatocoptes*). These have an ovoid body with long conical rostrum, long thick legs, all visible around the margin of the body, with ambulatory suckers, and in the male copulatory suckers and abdominal prolongations.

These live in colonies on the surface of the epidermis, seeking the shelter of the hair and later of the scabs which form from their bites and the consequent itching, rubbing, gnawing and scratching. They migrate in bodies when disturbed by comb or brush or by rubbing, and on this account as well as because of the crowding due to rapid encrease they tend to extend over the whole body. In warm weather they leave the shelter of hair and scabs to sun themselves on the hairs, and retreat again to their shelter on the advent of cold. Living on the surface it is comparatively easy to reach them by local dressing so that they are much less inveterate than the sarcoptes.

Symbiotes. (*Chorioptes, Dermatophagus*). These have an ovoid body, rounded at both ends, bilobed or simply notched posteriorly in the male ; rostrum conical, as broad as long, devoid of cheeks, mandibles thick, short, pincer-like, palpi in three segments ; legs thick, long, visible beyond the edges of the body, and with bell-shaped ambulatory suckers on short pedicles. Male has copulatory suckers.

Like the psoroptes, the symbiotes live on the surface sheltering under hairs and scabs. Their favorite habitats are the hol-

low of the pastern and digital region in horses and sheep, and the root of the tail in the ox, and for years they will confine their ravages to these points. When of old standing and overcrowded they may extend to other parts. From the limited area of their invasion and their life on the surface they are easily controlled by local dressings.

LIST OF PSORIC SARCOPTIDÆ.

In the following table the species under each primary division are sub-divided into the varieties which confine themselves more or less strictly to given genera as hosts :

Sarcoptes Scabei. Two pairs posterior legs incomplete in the female ; the third pair only in the male. Dorsum with many sharp pointed papillæ.

Sarcoptes Scabei varietas Hominis. Man.

Sarcoptes Scabei varietas Equi. Horse, ass, mule.

Sarcoptes Scabei varietas Caprae (*S. Rupicaprœ*). Goat.

Sarcoptes Scabei varietas Ovis. Sheep.

Sarcoptes Scabei varietas Suis (*S. Squamiferus*). Swine.

Sarcoptes Scabei varietas Lupis. Wolf, fox, dog, deer, man.

Sarcoptes Scabei varietas Cameli. Camel, llama, giraffe, antelope.

Sarcoptes Scabei varietas Canis. Dog.

Sarcoptes Scabei varietas Hydrochoeri. Ferret.

S. Notoedres. S. Minor. S. Muris. S. Felis. Cat, rabbit, rat, mouse. Anus dorsal, with undulating concentric elevations.

S. Mutans. S. Vulpis. Feet, comb, wattles, angle of mouth of hens. Fox. (Man, horse). Legs complete in male ; without ambulacrum in female.

Psoroptes Longirostris (Communis). Rostrum long, conical ; body ovoid, anus marginal in both sexes.

P. Longirostris varietas Equi. Horse.

P. Longirostris varietas Bovis. Ox.

P. Longirostris varietas Ovis. Sheep.

P. Longirostris varietas Cuniculi. Rabbit.

Symbiotes Communis (Spathiferus). Abdominal lobes of male square, and carrying five hairs in two bundles, the largest forming a spathe.

S. Equi. Horse.
S. Bovis. Ox.
S. Ovis. Sheep.
S. Capræ. Goat.
S. Cuniculi. Rabbit.

Symbiotes Ecaudatus (Auricularum). The tailless Symbiotes. Cat, Dog, Ferret: in concha.

Symbiotes Setiferus (Vulpi). Fox, neck, ears, tail.

SARCOPTIC ACARIASIS IN SOLIPEDS.

Sarcoptes scabei v. equi: Characters. Accessory causes: Poverty, crowding, filth, hot season or stable, mingling of animals, infected stalls, cars, boats, pens, yards, fields, posts, stones, fences, clothing, combs, brushes, rubbers, pole, shafts, harness. Susceptibility: S. of man may live on horse 40 days, also those of carnivora and goat. S. of horse may live on man 40 days, on ox, sheep, pig, dog and cat has very transient effect. On carcase become torpid, but not dead, on cooling. *Symptoms:* Incessant, intolerable extending itching, rubbing, hairs bristle, twist, break, drop, but a few remain, unlike ring-worm, scurf, abrasions, sores, pimples, pustules, sloughs, swelling, corrugation; discovery of acarus in sunshine or hot room, scurf under microscope, or tied on arm. *Diagnosis:* From pruritus, moist eczema, dermanyssus acariasis, psoroptic acariasis, symbiotic mange, phthiriasis. *Prognosis:* Favorable under good conditions. *Lesions:* Eruption, channels in brilliant light. *Treatment:* Segregation, clipping, burning hair, soaping, scrubbing, oil, apply acaricide. Relative activity of acaricides. Value of volatile and non-volatile acaricides; poisonous or non-poisonous to the horse; suppression of perspiration. Acaricide formulæ. *Prevention:* Burn litter, soiled fodder, etc.; clean and scald stable, sprinkle with acaricide (mercuric chloride, chloride of lime), whitewash, clean harness and smear with phenated or formaline ointment. Treat all objects that have been in the stable or in use about the horse. Disinfection of public places. Declaration of seller or custodian.

Essential Cause. **Sarcoptes Scabei Varietas Equi.** Body ovoid, marked division of cephalo-thorax into four plates, dorsal pupillæ very acute; dorso-abdominal bristles strong, straight, rigid; two anterior pairs of legs have suckers, the two posterior, terminal hairs; curved hooklets on the second segments of the first pair of limbs. Mature male .26 to .28 mm., ovigerous female .45 to .47 mm. Females by far the most numerous. A transverse chitinous ridge on the abdomen connects with the posterior pair of limbs, and with a horseshoe-shaped crest around the generative organs.

Accessory Causes. Besides the parasite other conditions favor the development of the affection. These are such as contribute to the survival or diffusion of the parasite, or tend to render the system a more inviting field for its growth. **Poor condition** is almost constantly present, but this is usually the accompaniment of **overcrowding, filthy buildings** and **yards**, and the **skin** has an **excess of dandruff. Warm seasons** and **hot stables** favor encrease of the acari, while cold renders them torpid and diminishes reproduction. Most injurious of all is the **mingling of diseased with healthy stock**, or, the **occupation of the same places in succession. Contamination of railroad cars, steamboats, ferry boats, market pens, stables, yards and fields, rubbing posts, trees, stones, etc.**, the use of the **same clothing, combs, brushes, rubbers, pole, shafts** or **harness** must all be looked upon as prolific sources of infection.

Susceptibility of Different Animals. The sarcoptes of man can be **conveyed to the horse**, on which it burrows and produces temporary acariasis, but this usually recovers spontaneously in 14 to 50 days (Delafond and Bourguignon). The same is true of the sarcoptes of the lion (Delafond and Bourguignon), cat (Hertwig), dog, fox (Gerlach), and goat (Wallraff).

The **sarcoptes of the horse** can be **conveyed to man**, and in the army hundreds of soldiers have at different times suffered (Sick, Megnin, Fleming, Longchamps, Geraud, etc.), but it tends to spontaneous recovery in from 15 to 40 days. Sick, Greve, Fauvet and Grognier have respectively seen the parasite transferred from horse to ox through the stalls and mangers, but we have no evidence that it will persist on the latter, and the **rarity of the affection in cattle** that have come in contact with mangy horses, implies that this sarcoptes finds in the ox an unsuitable field. Placed on the skin of **sheep** and **pigs** it did not produce even temporary irritation. On **dog** and **cat** it lived for a few days only. On **dead carcases** the sarcoptes become torpid on the subsidence of animal heat, and show no tendency to migrate after twelve hours. It would not be quite safe, however, to put such torpid acari on the warm skin of the living soliped.

Symptoms. There is incessant, intolerable and extending itching and rubbing of some circumscribed part of the skin, most

commonly about the head, roots of mane or tail, the withers, or the back. When these parts are scratched the horse inclines himself toward the hand and moves his lips as if he were himself nibbling the skin. When the affected part is closely examined it is found to be covered with an eruption of fine conical papillæ, many of which have a hair in the centre. The hairs of the affected part stand erect and bristly, and many drop off, or are rubbed out or twisted, but in the centre of the patch may still be noted one or more hairs tenaciously holding their place. This serves to distinguish from the absolutely bare, round patches of ringworm. The bare spots are at first scurfy, but soon become covered with yellowish scabs. True primary vesicles are rarely detected, but the constant rubbing and consequent inflammation cause more and more exudation, which concretes in scabs and crusts. Or from the continued rubbing, scratching and biting there are formed open sores, vesicles and pustules, and the subcutaneous connective tissue may be infiltrated and thickened with exudate, and the skin thrown into ridges by the contractions of the panniculus muscle. The intensity of the symptoms varies much with the stage and extension of the attack. The symptoms may be slight and equivocal in the first fourteen days, though exceptionally it makes great progress in this length of time. In any case by the sixth week the disease has usually made extensive ravages, and from this time on it advances with extraordinary rapidity. Such cases are marked not only by the loss, breakage and twisting of hair, by the marked abrasions and sores, and by the intense, encreasing pruritus, but also by marked loss of condition, which may go on to marasmus and death.

The most satisfactory symptom is the discovery of the **acarus.** By exposing the patient to the warm rays of the sun, or placing him in a hot room, the sarcoptes is tempted to leave its burrow, and climb on the crusts and hairs, where its presence can be detected by the aid of a lens. Or the crusts are detached from the skin and their deep surface examined when the parasite may be found in the midst of the epithelial debris. If the examination is made in a warm room under a low power, the movements in the scales caused by the active acari will help materially in their discovery. Should they still escape observation, the crust may be bound on the skin of the human arm, when, in a few minutes,

a pricking sensation is felt, and in twelve hours on the removal of the crust, the parasite is detected as a white point in the centre of a pale red papule. In case of doubt steep scurf in a ten per cent. solution of caustic potash and examine under the microscope.

Diagnosis. It is important to distinguish this acariasis from **constitutional pruritus** with papules, and **moist eczema.** these are likely to be more generally diffused over the body and the papules are likely to be more isolated, and the crusts are confined to the papules or vesicles. They also require constitutional treatment and are little or not at all affected by local dressings, whereas sarcoptic mange is quickly responsive to local treatment, and is unaffected by internal medication. The presence of the sarcoptes is even more conclusive.

The diagnosis from other forms of acariasis is less easy. **Dermanyssus Acariasis** is usually betrayed by the proximity of the horse's stall to filthy hen roosts, and accumulations of hen manure swarming with large grayish acari, which may also be found on the horse's skin especially at night. The depilations are on any part of the skin, as small isolated spots which do not tend to become confluent, whereas in *sarcoptic acariasis* they rapidly run together forming extensive patches. **Psoroptic acariasis** usually begins at the nape of the neck, extending along the mane, and at the root of the tail, and often confines itself largely to these points, causing much tumefaction and wrinkling of the skin, with free liquid exudate and abundant crusts. Sarcoptic mange extends more rapidly and generally. The psoroptes is easily known by its more oval form, longer limbs and long rostrum. **Symbiotic Mange** is easily distinguished by its location on the digits, by its indisposition to extend, by its being less contagious, and by the bilobed abdomen in the male parasite. **Phthiriasis** is easily differentiated by discovery in the affected parts of the **hæmatopinus tenuirostris**, the enlarged abdomen of the parasite standing out at right angles from the skin.

Prognosis. Sarcoptic Scabies is a purely local disease caused and maintained by the acari in the skin. The burrowing habits of the acari, however, and the difficulty of reaching all by acaricides, together with the extreme and constant irritation, the loss of rest, the exhaustion, the unfitness for work, tend to render the

disease extremely intractable and inveterate, and to lead to debility, anæmia and even death. The affection is dangerous in all, but preëminently so in the old, or very young, the weak, overworked, underfed, filthy, ungroomed animals kept in close foul stables. Army horses, in campaign work, are dangerous subjects. The more recent and circumscribed the affection the better the hope of the speedy and complete recovery under energetic treatment.

Lesions. In addition to the morbid phenomena seen in life, the burrows and galleries may be shown in a fragment of infected skin, which has been kept in moist warmth for 24 to 48 hours and the loosened epidermis removed by forceps and scalpel. In a bright light a magnifying lens shows the channels straight or winding, 2 to 4 mm. long, with at intervals enlargements or galleries each containing two or three eggs or egg shells, and in the terminal one the ovigerous female. A general yellow infiltration under the skin may be so abundant over the galleries as to form a vesicle, and in other cases it dries up so as to cause hard, thick epidermic crusts and scales. The implication of the hair follicles causes depilation, and the dermatitis leads to subcutaneous engorgement, especially noticeable in the limbs (Delafond and Bourguignon).

Treatment. On the first indication of mange the horse must be separated from all others, also all his belongings, clothes, brushes, combs, rubbers, scrapers, harness, pole and shafts. The disease must be accurately diagnosed by the discovery of the sarcoptes.

Clipping of the entire animal is essential to reveal every isolated and unsuspected point of attack and to facilitate the application of dressings. This must be done outside the stable on a calm day and all the hair must be carefully gathered and burned. The skin is then thoroughly lathered with soft soap and left for an hour or more to soften the scabs. Then it is thoroughly scrubbed with a brush and warm water, scraped and rubbed dry with straw wisps. These should be burned or saturated with a solution of mercuric chloride (1:500) or chloride of lime (4:100). If specially hard obstinate crusts remain, repeat, or smear with sweet oil and potassium carbonate (100:2).

The skin is now ready for the application of the acaricide, and this seems a convenient place to introduce a table of those more commonly used and showing the time taken by each to kill the acarus apart from the body. The application is general to scabies in all classes of psoric acari and their hosts.

In making a selection from such a list we must consider the fixed or volatile nature of the agent. Such agents as benzine, naphtha, petroleum, prussic acid, etc., though very deadly to the acarus, volatilize so rapidly that they are on the whole less reliable than mercury or sulphur, which are among the very slowest acaricides. The less volatile products of the distillation of wood and coal

TABLE SHOWING THE RELATIVE ACTIVITY OF ACARICIDES.

	Hrs.	Min.	Sec.	
Oil of tar (rectified) killed acarus in			1–25	
Terebane			1–30	
Benzine			1–20	
Prussic acid			5	
Creosote			5–20	
Naphtha			30–45	
Tobacco liquor of factories		½–1		
Veratrum—vinegar of		2		
Parafin oil		2	10	
Arsenite of potash solution (1:100)		2	20	2–3 hours (Hertwig).
Caustic potash solution (1:24)		2–2¼		
Empyreumatic oil		3–4		
Carbolic acid, pure		5		
Oil of turpentine		5–9		
Petroleum		5–9		1–2 hrs. in my experiments.
Glycerine (acarus immersed)		6		
Tincture of iodine		6		
Oil of Organum		7		
Dilute sulphuric acid (1:24)		7–8		
Tar water		8–13		
Tincture of digitalis		8		
Tobacco decoction (1:5)		10–20		
Mercuric chloride solution (2:100)		10		
Tincture of nux vomica		10		
Stavesacre—vinegar of		17		
Fusel oil		17		
Calcium chloride solution (1:30)		15–30		
Potassium sulphide solution (1:10)		15–30		
Acetic acid (glacial)		18		
Phosphureted oil	1			
Mercurial ointment	4			
Hellebore, white and black—decoction (1:16)	6–36			
Sulphur ointment				Several hours.

tar, such as oil of tar, creosote, and many of the more modern products (hydronaphthol, benzonaphthol, naphthol, napthalin, chloronaphtholeum, creolin, cresylol, cresyl, cresol, lysol, aseptol, etc.), are more trustworthy than the volatile in spite of the fact that they act much more slowly on the parasite. This applies with especial force to the sarcoptes which, hidden in their galleries, escape the volatile agent, and when they do come out of their burrows somewhat later, find themselves unharmed, the deadly agent having evaporated. In regard to the eggs to be hatched a few days in the future, the same is true. When the embryos open the shell, the deadly but volatile agent has disappeared, while the more stable, even if less deadly, agent remains ready to destroy them. For sarcoptes the very volatile agents would require renewed applications at short intervals to catch the acari as they emerge from their holes, and the larvæ as they escape from the eggs. **Benzine, naphtha** and **petroleum** are further dangerous as irritants of the excoriated skin, retarding healing and making recovery doubtful.

Another consideration in dealing with domestic animals is the use of an agent that will not poison the patient when he licks himself. **Tobacco**, a slow acaricide is yet very lasting and effective and may be used freely on the ruminants and even the solipeds, which have almost no susceptibility to nausea. In carnivora on the other hand it would cause violent nausea and vomiting and dangerous illness. **Arsenic** and **Mercurial** preparations kill the acarus slowly, yet being comparatively non-volatile one application is lasting and efficient. But any animal licking and swallowing these will be poisoned, perhaps fatally. Even apart from this the agents are liable to be absorbed through the raw or excoriated skin, to be swallowed as drink, or to be washed off during rain on to the pasture and taken in with the food. Of the two classes of agents, represented by oils or ointments on the one hand and lotions and baths on the other, the latter is preferable unless the skin is so covered as to shut out the air. This in itself would asphyxiate the parasite irrespective of the active agent. But again a complete inunction of the whole body is liable to arrest cutaneous transpiration and cause subnormal temperature and internal congestions. Hence with universal oily dressings it is safer to cover but one-half of the body at a time and to alternate the sides at intervals of one or two days.

The skin having been well prepared by the softening and removal of the crusts, one of the following may be used or several in succession: Creosote 5 parts, alcohol 5 parts, water 25 parts; creosote 1 part, lard, vaseline or oil 25 to 40 parts. Thoroughly rub in two or three times at intervals of from three to five days. Oil of tar may be used in the same combinations. So with the other coal tar products. Lysol, aseptol, creolin, and chloronaphtholeum are most conveniently mixed with water; naphthol, and naphthalin, in alcohol or oil; and benzo-naphthol in alcohol. Carbolic acid 1 part, oil 40 parts may be used and relieves itching somewhat. Tar water may be applied, or tar 1 part, vaseline or lard 3 parts, to be used on a limited area only, lest it check transpiration. Or tar and sulphur ½ lb. each, green soap and alcohol 1 lb. each (Röll). Tobacco 1 part, water 25 parts, in decoction acts well, or as a cheaper agent the refuse of the tobacco factories 2 ozs., oil 1 lb., sulphide of potassium 1 part, water 25 parts is effective. Or potassium sulphide 10 parts, potassium carbonate 2 parts, lard 300 parts; or sulphur 2 parts, potassium carbonate 1 part, lard 8 parts; or powdered cevadilla 4 ozs.; burnt alum 1½ oz., sulphur 2 ozs., olive oil 1 quart.

The itching may be lessened by lotions of acetate of lead or inunctions of eucalyptol or menthol in oil.

In cases that are weakened or emaciated a rich diet and a course of tonics (nux vomica, gentian, iron, or arsenic) may be resorted to.

Prevention. Any stall that has held a horse with scabies or a suspected one should have any litter, manure, and fodder contained in it removed and burned, every precaution being taken against dropping anything on the way to the fire. The stall should then be deluged with boiling water or treated throughout to live (colorless) steam from a hose. In the absence of either, it may be heavily sprinkled with a mercuric chloride solution (1:500), or one of chloride of lime (1 lb. to 20 gallons). Next day a lime whitewash should be applied to every part (walls, ceilings, racks, mangers, and floor. The stall should be left empty for at least one week. If a whole stable has been contaminated every article within it should be similarly treated. Harness pegs and saddle trees must be particularly attended to, corn bins, troughs, buckets, forks, shovels, etc., being scraped,

washed with a formaldehyde solution (5:100) and allowed to dry before they are again used. All harness should be taken to pieces, scrubbed in warm water containing phenol or formaline (5:100), rinsed in hot water, dried and oiled. Any parts made of cloth, and all metal work, bits, curb chains, stirrups, spurs, should be steeped in boiling water for five minutes. When the padding of harness cannot be treated as above directed it may be ripped out and replaced. All combs, brushes, scrapers, rubbers, clothing, circingles, and halters should be kept for five minutes thoroughly soaked in actively boiling water. The clothing of the attendants, their combs and brushes should be similarly dealt with. The poles and shafts of carriages should be dressed with mercuric chloride.

Horses that occupied the stalls to the right and left of the affected one, are to be suspected, treated with one of the dressings above referred to and kept in quarantine for a week.

When a horse with scabies has been in a stable, public or private, in a sale-stable, horse show, stockyards, car, steamboat, ferry boat, or other vehicle, these places and articles should be closed or disused until treated by the above or some other thorough method of purification. Whenever a succession of cases of scabies have been carried along a given line of travel, the animals coming by such line, should be held in quarantine and treated until the vehicles and any feeding places or yards used on it, are thoroughly treated. Exception may be made of horses arriving in cars, etc., that have been newly cleaned and whitewashed, and when evidence is furnished that they have not been disembarked at suspected places on the way. For the same reason the owner or custodian of any horse arriving by rail or boat, or brought to any sales-stable, fair, market or show, and which is suffering from any skin disease, should be under obligation to report the same to a government veterinary official for diagnosis, and a penalty should be imposed in case of disobedience. In this case as in all other instances of dangerous infectious disease the protection of the many must dominate over the inconsiderate and selfish assertion of individual rights.

PSOROPTIC ACARIASIS IN SOLIPEDS. DERMATODECTIC (DERMATOCOPTIC) SCABIES. HUMID MANGE.

Psoroptes Communis v. *equi:* Long rostrum; posterior pair of legs small, without suckers; male with two posterior marginal 5-bristled lobes; in female 3d pair of legs, without suckers. Accessory causes as for sarcoptes. Vitality greater than in sarcoptes. *Susceptible:* Live only a short time on other genera. P. of rabbit lives on horse. *Symptoms:* Extend more rapidly and are more venomous than sarcoptes. Preference for dorsal line, poll to rump; later the axilla, groin, inner sides of thighs, intermaxilla; itching and lesions largely as in sarcoptes. Diagnosis easy, the acarus being on the surface. *Treatment:* As for sarcoptes, but more promptly successful. *Prevention:* As for sarcoptes.

Essential Cause. **Psoroptes Communis var. Equi. Psoroptes Longirostris. Long-nosed Psoroptes.** With the general characters of the psoroptes this is especially distinguished by the great length of the rostrum, more than twice as long as broad; in the male by the dwarfed appearance of the posterior pair of legs devoid of suckers, and the presence on the border behind the two copulatory suckers, of two triangular, projecting, marginal lobes, each bearing five bristles, the three central, terminal ones being the longest and about equal; in the female the third pair of legs have no sucker, but each is terminated by two long bristles, the fourth pair have suckers; the pubescent female has two tubercles near its posterior border which are received into the copulatory suckers of the male; the larva has the third pair of legs provided with suckers. The male is about .48 mm. and the ovigerous female about .65 mm. long.

Accessory causes. These are the same as for *sarcoptic acariasis*, only from the parasite living exclusively on the surface and not beneath, it passes from horse to horse with much greater readiness, and is by far the most common form of equine mange.

Vitality. The vitality exceeds that of the sarcoptes. Apart from the host it survived 10 to 14 days in a dry, genial atmosphere, and 20 to 30 days in moist stable air. Though apparently dead it will often revive after six or eight weeks when subjected to moist warmth. It does not bite, however, nor cause psoric trouble. The ovigerous females survive the longest, and after them the males and then the larvæ.

Transmission between different genera. Though no difference in structure can be detected in the psoroptes of the different genera of hosts, yet when transferred from one genus to another they rarely live long, but any eruption recovers spontaneously. According to Mathieu, Cagny and Cadeac an exception must be made in the case of psoroptes auricularum of rabbits which in their hands caused persistent acariasis in the horse. Others have failed to transmit from the rabbit to the horse. The camel contracts the disease from the horse.

Symptoms. There is the same intolerable itching which attends on sarcoptic scabies, in many cases aggravated partly because of the rapid encrease of the parasites and centrifugal extension of the infested area, and partly because of the secretion of a more irritating venom. This last was shown by Gerlach, who took on a needle the liquid exuded around the sarcoptes and psoroptes respectively and punctured his own skin, when the irritation which followed was materially greater in the case of the psoroptes. While psoroptic scabies may be planted on any part of the body, except perhaps the digits, and extends as a rule in all directions and rapidly from the primary focus, yet a distinct preference is shown for the parts covered by the strongest and thickest hair (crest, rump, poll, back) where the most perfect protection can be secured. There is less opportunity for its spread on comb or brush from these parts, hence at the outset there is less disposition than with sarcoptic mange to the formation of many new centres at distant points. After an existence of a month or more the psorptes may still be mainly confined to the crest or rump. In extending it invades by preference the intermaxillary space, the breast, axilla, groin, and inner sides of the thighs. Transference of the acarus in grooming may, however, start it at any point. At first the bites and resulting sores or vesicles are mainly isolated, but as the psoroptes encrease and crowd each other the sores become confluent, and the exudate, infiltrating and covering the already depilated skin, makes a scabby, cracked, oozing surface, or when the scabs are rubbed off it is smooth, shining and unctuous. The skin is greatly thickened, rigid, or thrown into wrinkles. The itching and rubbing are more intense and desperate than even with the sarcoptes.

Diagnosis is always easy because of the non-burrowing habit of the psoroptes. By scattering the scrapings on a glass slide or

black paper in the sunshine or in a warm room and examining with a hand lens, a movement of the scabs can soon be detected at some particular point, and the acarus soon emerges and can be recognized. It can be seen still better with the microscope under a magnifying power of 25 or 50 diameters. If no magnifying lens is at hand a scab can be laid on the skin of the arm and held with a bandage. In an hour or two a pricking sensation is felt and on removing the crust a red papule is found with the psoroptes in its centre. Or by clearing the scurf in 10% solution of caustic potash the acari are left in the field alone.

Treatment does not differ materially from that given for sarcoptic mange, and it is much more promptly successful owing to the non-burrowing habits of the acarus. When recent and confined to the crest and root of the tail, a general clipping of the body may be avoided, and even the hairs of the mane and tail may be spared save where they are buried in the folds of the corrugated skin. The same preparation with soap and warm water and a brush, is requisite, and in selecting an acaricide Röll's prescription of tar, sulphur, green soap and alcohol may be freely used without fear of suppressing secretions and asphyxiating the patient. Where the disease is generally diffused, on the other hand, the other preparations are safer.

Preventive measures are essentially the same as for sarcoptic mange. Where a building, car, yard or park has become infested, and is not treated with acaricides, it can only be considered quite safe after a disuse of three months, owing to the great powers of survival of the psoroptes.

SYMBIOTIC SCABIES. ACARIASIS IN SOLIPEDS. FOOT MANGE. GALE DU PIED, Fr.; FUSSRÄUDE, Ger.

Symbiotes communis v. equi: Smaller than psoroptes; proboscis shorter; two front pairs of limbs, very long and thick; two posterior pairs, devoid of suckers in female; male has two caudal lobes, each with two bristles and two central leaf-like processes. *Symptoms:* Itching heel and fetlock in hind limbs; exceptionally to hocks and thighs. Pawing, kicking, scratching, biting, especially at night and in winter, and in hairy-legged cart breeds. Bristling, depilation, scurf, scab, papules, cracks, excoriation, sores, profuse fœtid discharge, stocking, presence of acarus on surface. May be

months ere it passes to the horse alongside. *Treatment:* Simple, clip, soapy wash, and inunction; wash off and apply acaricide, tobacco, tar water, sulphur, potassium sulphide. *Prevention:* As for sarcoptes. Symbiotes lives 50 days in stable.

Acarus. The **Symbiotes Communis Var. Equi** (**S. Spathiferus**, Megnin; **Dermatophagus Equi**) is much smaller than the psoroptes, the ovigerous female being .36 to .40 mm. long, and the mature male .28 to .32 mm. The rostrum is only a little longer than broad; the two front pairs of limbs are very long and thick, the third pair large, and the fourth short and thin. There are no suckers on the third pair of limbs in the female. Behind its two copulatory suckers, and on the posterior margin of the body, the male has two prominent, retangular lobes, each bearing two bristles and, centrally, two long, flattened, foliaceous processes or spathes.

Symptoms. The disease is characterised by its location on the pastern, hollow of the heel and fetlock, mainly of the hind limbs, from which when crowded the acari extend upward to the hocks, exceptionally to the legs and thighs and still more rarely to the croup, abdomen and loins. The first indications are an incessant pawing or kicking of the ground, or scratching of one pastern with the other foot. The patient may kick straight out, or turn and attempt to bite the affected pastern. The itching is usually greatest at night and in winter or when the horse stands idle in the stable. Shoeing is often difficult owing to the horse trying to rub his foot against the operator. The disease is much more common in heavy cart breeds, as imported Belgians, Suffolks, Shires or Clydes, in which the long and abundant hair gives better cover for the parasite and stands in the way of thorough cleanliness. The same breeds born in America part with their long hair and are in some degree immune. Examination of the affected part shows a bristling and loss of hair, an accumulation of scurf and scabs, with an eruption of papules and the formation of cracks, excoriations and extensive sores, and a free unctuous, fœtid discharge. Even at an early stage the hair is loosened so that it can be pulled out in tufts. Later the skin becomes thickened and rigid, sometimes wrinkled and folded, and stocking is by no means uncommon. It is characteristic of the disease to advance slowly, though the itching of the affected

part is intense and insufferable, especially in the cold weather. As in all forms of symbiotic scabies there is some relief in summer, when the freer secretions of the skin furnish the parasite with abundant food and obviate the necessity of active biting. The discovery of the symbiotes is easy and completes the diagnosis.

A misleading feature of the disease is its failure for months to extend from animal to animal in adjacent stalls. Yet the experimental transfer of the acarus immediately starts the disease in the new subject.

Treatment is simple and usually promptly successful. Cut off the hairs from the affected part and a little beyond. Wash with soapsuds leaving a strong lather on the surface for half an hour. Then wash off with tepid water using a brush if necessary to insure the thorough removal of the scabs. When dried apply any one of the less volatile dressings named under sarcoptic scabies. The tobacco lotion; the tar, sulphur, soap and alcohol dressing; or the potassium sulphide preparation is very effectual. A second dressing and even a third may be requisite at intervals of two or three days.

Prevention. Though contagion takes place slowly and uncertainly, yet similar precautions are in order to those adopted for sarcoptic scabies. The use of the same stall and litter, of the same brushes, rubbers and sponges is especially to be prohibited. It is also important to avoid stables, cars, yards, boats, etc., that have held diseased horses, or that are reasonably suspected of the same. All such should be thoroughly cleansed, and affected animals should be debarred from public places and conveyances unless they are to be immediately dealt with in this way. The symbiotes will live 50 days in an untreated stable. (See prevention of sarcoptic scabies).

SARCOPTIC SCABIES IN THE OX.

Sarcoptic scabies, rare: *Psoroptic scabies:* Psoroptes communis v. bovis, like that of horse. *Symptoms:* Intense itching on rump, thighs, neck, chine, back, head, shoulders, side, rubbing, scratching, licking, depilation, excoriation, bleeding, exudation, scabbing, swelling, vesicles, acarus in crusts. Favoring conditions as in sarcoptes in horse. May, in great part, subside in summer to reappear in winter. *Treatment:* As in horse, only avoid mercury. *Prevention:* As in sarcoptic scabies in horse. *Symbiotic scabies:* Symbiotes scabei v. bovis. *Symptoms:* Itching and eruption on rump, with little extension, baldness, scabs, cracks, abrasions, sores, etc., along back, in groin, on pasterns, chronic. *Treatment:* As for psoroptes; dressings limited to affected area.

Isolated cases of sarcoptic scabies communicated from the horse are reported by Grognier and Fauvet, and others from the goat by Wallraff, but the affection is so rare that it may be virtually ignored. Cases of this kind may be treated as in the horse.

PSOROPTIC SCABIES IN CATTLE. DERMATODECTIC (DERMATOCOPTIC) MANGE.

This is the most common form of mange in cattle as it is in the horse. The essential cause, the **psoroptes communis var. bovis** does not differ in appearance from that of the horse, and it is mainly in its adaptability to live on the bovine rather than the equine animal that the distinction can be made. Gerlach and Delafond each failed to transfer the psoroptes from horse to ox, and Gohier and Müller equally failed in attempts to convey that of the ox to the horse. Exceptions to this are probably mistakes.

Symptoms. Most commonly the first symptoms are seen at the root of the tail and sides of the thighs; soon the neck, chine, back, head, shoulders and sides are involved, while the lower parts of the limbs escape until later. There is insufferable itching for which the patient rubs, scratches and licks himself incessantly, and hastens not only the loss of hair but the formation of excoriations, bleeding, exudation, liquid effusion and swelling. The exudation concretes into grayish white crusts, easily reduced to powder and showing beneath them abrasions and cracks.

Around the margins of the affected part may be found small miliary vesicles, which burst and dry up forming an encrustation of encreasing thickness. As the result of the constant rubbing, licking, etc., larger sores of all kinds may be developed. The psoroptes may be found in large numbers beneath the crusts, and may be detected with the naked eye or better with a lens, when the crusts are placed on a sheet of black paper.

The disease is favored by the housing in close foul stables in winter, and the parasite is driven downward by the cold to attack the skin and cause greater irritation. When the stock is turned to pasture in spring the irritation often ceases in a great measure, the freer secretions supplying the wants of the parasite so that it does not care to bite. There remain, however, bare spots on the neck, rump and elsewhere, and when once more turned into winter quarters, the apparent recovery is succeeded by a new and wider extension.

The *treatment* of psoroptic scabies in cattle does not differ materially from that of the horse. It is, however, important to avoid preparations of mercury to which the bovine system is specially susceptible, and which, taken in by licking with the barbed tongue, or directly absorbed through the abraded skin is liable to cause mercurialism and salivation. The other agents, tobacco, tar, oil of tar, lysol, creolin, creosote, naphthalin, potassium sulphide, in their various preparations may be freely used after the skin has been prepared by soaking with soap suds and thorough brushing. Special irritation may be counteracted in the same way, and debility by better hygiene and diet.

Prevention demands the same general precautions, proprietary and official, as in the case of the horse.

SYMBIOTIC ACARIASIS IN CATTLE.

The essential cause of this affection, the **Symbiotes Scabei var. Bovis, (Dermatophagus Bovis)**, does not differ in appearance from that of the horse. As in the case of the psoroptes the distinction of the two varieties affecting horse and ox must be made from the fact that the symbiotes taken from the ox does not establish itself permanently on the horse, nor that of the

horse on the ox. Upon the horse the transferred acarus disappears in a few days (Neumann), and on the ox (debilitated), in twenty days (Delafond and Bourguignon). They do not live when placed on any of the other domestic animals, nor on man. Schírémétewsky claims to have found the bovine symbiotes in scabies and alopecia in man, but there is not sufficient evidence to show that the presence of the acarus was more than accidental. Contagion from ox to ox, standing in adjacent stalls is infrequent.

Symptoms. The lesions are usually confined to the root of the tail, the rump and the parts around the anus, and the acarus may confine its ravages to this part for years without material extension. There is loss of hair, and accumulation of scurf, going on to the formation of scabs and cracks in which the parasite can be found in abundance. Itching is comparatively slight, so that abrasions and sores by rubbing are less marked than in other forms of scabies. Extension from the original focus takes place mainly in foul, ungroomed animals, and then along the back, chine, and neck, or to the perineum, udder and inner sides of the thighs. Johne has found them on the pasterns without producing any irritation. In summer the irritation is least and may seem to have entirely disappeared, but only to reappear when housed, the following winter. In animals in poor condition it may contribute to emaciation, and marasmus, but in ordinary cases the health is little affected.

The *diagnosis* is to be made by the location and slow advance of the lesions, but especially by the discovery of the symbiotes with its moderately sized rostrum and the long stout nature of the three first pairs of limbs as contrasted with the dwarfed appearance of the fourth pair. The presence of lice, easily visible to the naked eye and of the psoroptes, is not unknown, but as the same treatment is applicable to all, the complex infestation is of less account.

Treatment. Symbiotic scabies in cattle is easily dealt with, any of the applications recommended for sarcoptic scabies in the horse proving effectual. It is all the more satisfactory that the disease is usually circumscribed to a limited area, so that the clipping and dressing of the entire skin is unnecessary. Precautions should be taken against infection from stalls and litter, but this is of far less account than in the case of other forms of scabies.

SARCOPTIC SCABIES (ACARIASIS) IN SHEEP. HEAD SCAB. BLACK NOSE.

Sarcoptic scabies of sheep's head: Black-nose: Sarcoptes has 6 anterior and 14 posterior dorsal spines. May extend to body in coarse-wooled; goat and man susceptible. *Symptoms* of scabies confined in fine wools to face, lips, nostrils, eyelids, ears, forehead, cheeks, intermaxilla. In all seasons and places, unlike trombidiosis; rubs face on fore limbs, etc., scratches with hind feet; abrasions, scabs, sores, thickened skin; mucopurulent discharge from nose and eyes, etc. *Treatment:* Oil of cade, tar soap, sulphur ointment, potassium sulphide, naphthalin, etc. Cloth cover on face. Remove from infested premises. Make exposure or sale penal.

The burrowing mite which causes this disease confines its ravages almost entirely to that portion of the face which is uncoverd by wool. Hence it has been named black muzzle, *noir-muzeau*, in France. Its cause, **Sarcoptes Scabei var. Ovis**, is distinguished by having on its back six anterior short spines and fourteen long and fusiform posterior spines. The length of the male is .22 to .25 mm., and of the ovigerous female .35 to .49 mm.

This has been found on moufflons and gazelles, and on long-wooled sheep, especially the Neapolitan, Syrian (fat-tailed) and Zackel sheep. Gerlach failed to propagate it on the wool-covered portions of Merino sheep, but on the long-wooled, with little yolk it can be implanted on any part of the body. It has been successfully transferred to goat and man (Delafond, Gerlach) persisting until checked by treatment.

Symptoms. An itchy eruption confining itself to the hairy parts of the face is to be especially suspected. It usually attacks first the lips, nostrils, eyelids and ears, advancing later on the forehead, intermaxillary space and cheeks. It might at this stage be confounded with trombidiosis, but unlike that, it persists in all seasons, in yard-fed as well as in pastured sheep, and does not recover when folded for a few days, on dry food. If it continues for a length of time, it extends from its primary point of election on the head, invading first the parts uncovered by wool—the lower surface of thorax and abdomen, and the flexures of the knees, hocks and pasterns.

If examined closely when just commencing, or later around the margins, beyond the excoriations caused by rubbing, there

may be detected minute papules, surmounted in some cases by vesicles. When rubbed gently, the animal expresses its pleasure by rapid movements of its lips or even of its feet or body, as if anxious to take part itself in the friction. Left to itself the affected sheep rubs its face on the fore limbs, or other objects and scratches it vigorously with its hind feet, producing abrasions and exudates, which latter dry into scabs and crusts, at first thin and isolated, but later thick, hard, resistant and continuous over the whole affected surface. This incrustation becomes more or less discolored by exuding blood, and by extraneous matters of many kinds deposited in rubbing the sores.

Neglected, the skin becomes thick, rigid and plicated, the lips unable to act in prehension of food, the eyes watery or closed by a mucopurulent discharge, and the ears the seat of hæmatoma owing to the violent scratching.

Treatment. Treated early, the disease is easily cured by the application of some one of the acaricides recommended for the horse. As simple applications, oil of spike, or oil of cade, have been specially recommended. So has a mixture of equal parts of pine tar and soft soap. Or sulphur 2 parts, potassium sulphide 1 part, lard 8 parts. The preparations with naphthalin, creolin, lysol or oil of tar will be equally effective.

In advanced cases a thorough smearing for several days with sulphur ointment to soften the scabs, and the removal of the latter with the aid of warm soap suds, may well preface some other form of treatment. It may further be advantageous to cover the face with a thick cloth or leather to protect the applications, and to obviate further irritation by scratching and rubbing.

As an essential part of the treatment the removal of the flock to a non-infested sheepfold or pasture or the thorough disinfection of that in which they have been kept is essential. All rubbing places, stones, posts, fences, trees, gates, etc., must receive special attention and dressing.

In France the movement or public exposure of any sheep affected in this way is forbidden, and with a disease so easily recognized it should be made a misdemeanor to ship the affected animals by any public conveyance, to expose them on any public highway or unfenced place, or to take them to any public market, show or other aggregation of sheep or goats. It should further be made

obligatory on all owners to eradicate the disease from the flocks, for though incomparably less contagious than the ordinary *scab*, yet there can be no excuse for perpetuating a public menace which is so easily recognized and done away with. The purifying of conveyances and all public places where such infested sheep have been should come under the same rule as for the more familiar *scab*.

PSOROPTIC ACARIASIS (SCABIES) IN SHEEP. COMMON SCAB.

Prevalence. Losses. Psoroptes Scabei v. Ovis like that of horse. Only lives permanently on sheep. Vitality ; lives 10 to 20 days in wool, on pelts, or woodwork, in genial weather ; dies at zero, Fah. *Accessory causes:* Poverty, crowding, mingling, infected places and things, commons, markets, railroads, boats, pens, etc. *Symptoms:* Fleece flattened or ragged ; white semi-detached tufts, shaking tail, rubbing, scratching with hind feet, trembling and nibbling with lips, itching increased by heating, crowding, driving ; skin with papules, scurf, exuvia, swelling, exudate concretes raising wool from follicles, bare patches with sores and eruptions ; wooly parts mainly affected, back, shoulder, neck, tail ; also the fine wooled. Lambs of clipped, scabby ewes suffer. Lymph glands swell. *Diagnosis:* Inveterate itching along dorsal aspect, excessive debris in the roots of the wool, and presence of the acarus. *Treatment:* Nourishing food, open air, in summer shear, apply acaricides by smearing, pouring or bathing. Smearing, salving mixtures should contain turpentine and castor oil to increase growth of wool. Pouring mixtures : tobacco, soft-soap, sulphur and oil of tar. Dips : Arsenical, their dangers ; mercurial, their dangers ; lime and sulphur, with sulphur greatly in excess to save the wool ; potassium sulphide ; carbolic acid ; tobacco ; tobacco and sulphur ; coal tar products. *Prevention :* Compulsory report of disease ; segregation ; disinfection of premises ; prohibition of exposure or sale ; damages for neglect ; trace and quarantine all sheep or goats that have been exposed in transit, market or otherwise ; compulsory official treatment ; fines for violation ; dipping sound sheep just before shipping ; coöperation of national and state authorities.

This is one of the most destructive plagues of sheep in some countries and districts. In France it attacks 1,000,000 sheep yearly at a loss in wool and mutton of about $1 a head. (Delafond). In Germany the losses are no less. In England from 5 to 25 per cent. per annum have suffered in certain districts. (Gamgee). It is the terror of importers of Mexican sheep, and in the seventies it became so prevalent on the prairies of Iowa

that it virtually ruined the local sheep industry. Even to the present time and in our eastern markets scabby sheep are frequently presented, and the railroad rolling stock, feeding yards and market pens become contaminated infesting all coming shipments, and transmitting the disease to the home flocks of the unwary flockmaster.

The parasite (**psoroptes scabi var. Ovis**) presents such insignificant differences in size and otherwise from the species infesting horse and ox respectively that it cannot well be distinguished by external appearance alone. It presents the general characters of the psoroptes communis, but otherwise it must be distinguished by its habitat on the sheep the only animal on which it has been found to make a permanent home. Transferred to the skin of man or of other animals it bites and causes transient irritation but speedily dies.

Vitality. Experiments of Hertwig, Gerlach and Delafond show that apart from the living sheep, this psoroptes can live on wool or fresh skin, or even on litter or woodwork for from ten to twenty days. In genial weather it remains active, and in cold it becomes torpid, but when subjected to moist warmth it soon resumes its active movements. It dies promptly if the litter, wool or other objects, in which it hides, are subjected to a zero temperature.

Accessory Causes. In so destructive a parasitism, everything that favors infection should be constantly kept in mind. Poor, low conditioned and neglected sheep are especially receptive of the disease, but this must not be held to mean that it is safe to expose the finest, best kept and most thrifty animals. It refers rather to rapidity of progress of the malady caught, and the sinking of the individual sheep under its effects, than to any chances of escape from infection. Crowding of sheep together, as in pens for washing, shearing, shipping, etc., gives more abundant opportunity for transference of the parasite and renders it much more active. Shearing, by exposing the infested skin more thoroughly, favors the lodgement of the acarus on the skins of others directly or on rubbing posts, stones and other intermediate bearers. The neglect of clipping may act injuriously as the tufts of wool which are shed, and left in pastures, yards and on rubbing objects carry the parasite with them. Unfenced

pasturages are among the most prolific causes, as the mingling of flocks, diseased and healthy, their successive pasturing and resting on the same ground, and their use of common objects for rubbing ensure the spread of the psoroptes. This explains the great prevalence of the disease in the unfenced common pasturages of central Europe and Asia, of Syria, North and South Africa, of Australia, Argentina, Mexico, and our Western Plains, also, in the early days, in Iowa and elsewhere before the land was enclosed. Moving infested flocks by road comes under the same category. So the modern methods of transit by rail and boat, the concentration of the parasite in the lines of travel and its diffusion to each successive shipment become most injurious. The roads, loading yards and banks, chutes, cars, litter, manure, feeding yards, stock yards, alleyways, sheephouses and stock trucks become infested in turn, and each remains for two weeks or more a centre of infection. A single infested flock can thus establish a long chain of infested centres, each of which becomes an active source for the diffusion of the disease. The constant succession of ovine shipment furnishes daily fuel for the flame, so that once started these disease-foci are likely to be sources of permanent trouble. Show-rings and pens hold a very secondary place, as unless newly infested, scabby sheep are rarely in condition for exhibition. Again, an animal only just infested, with its paucity of acari, is immeasurably less likely to transmit the parasite, than is one far gone with the disease, swarming with acari and with the infested portions of the skin stripped of their wool.

Symptoms. The affected sheep attracts attention by the rough state of its fleece at the affected part, the wool being flattened or ragged, with white tufts rubbed out or pulled out by the teeth. It shakes its tail, rubs its body, scratches with its hind feet, and tears with its teeth in a way to show intolerable pruritus. If the affected parts are rubbed with the hand the patient shows its enjoyment by the scratching movements of the hind limbs, the trembling and nibbling with the lips, and movements of the head and body as if rubbing. The itching is encreased by driving or by crowding together so as to heat the sheep and induce perspiration. The skin of the affected part is covered with yellowish papules of varying size, and a marked accumulation of

scurf among the roots of the wool. Later the affected skin swells uniformly, and the encreasing exudation concretes into a massive scab enveloping the roots of the wool, so that as it encreases layer by layer on its deeper surface, it lifts the fibres out of their follicles, detaching the wool and leaving extensive bare scabby patches. The denuded surface shows all the variation of lesions shown in other mangy animals. Papules, vesicles, pustules, scabs, cracks, excoriations, and even sloughs may appear at different points. Sometimes in clipped sheep the exudate forms a uniform, smooth, parchment-like crust covering the whole exposed area. Around these bare patches the wool is encrusted at its roots, or shows a dark, dirty, scurfy layer composed of epidermic cells, yolk, dried exudate and the exuviæ of the acarus. Beneath this the parasite is found in myriads. The bare spots may show comparatively few. The intense itching of these parts and the readiness with which the wool can be pulled out are significant.

Unlike the sarcoptes and symbiotes, the psoroptes attacks by preference the parts that are thickly covered by wool, and generally respects those having a hairy coat only. For the same reason it is especially inveterate on fine wooled sheep, the density of the wool and the abundance of yolk furnishing a better protection than in the long wooled. In all, the affection is to be looked for primarily along the back, shoulders, neck and tail, then on the sides of the body, arms, haunches and thighs, and not at all on the bare face, belly, inner sides of the limbs and lower surface of the tail. Another noteworthy point is that lambs which have a good covering of wool are liable to be severely attacked just after the clipping of their dams, the parasites migrating in numbers to the animal which furnishes the greatest measure of protection.

The changes in the wool, in old standing cases are marked. It may be dry, rigid and lustreless from being cut off from its source of nourishment; it may be thickened at both ends and thin in the centre of the fibre the latter corresponding to the period of extreme cutaneous congestion and impaired nutrition; or it may be composed throughout of fibres of unequal length, the short being those that have started since the irritation has lessened. These conditions of the wool may result as well from

variable feeding—rich and poor,—or good or bad general health, so that they must not be looked on as peculiar to scabies. They greatly reduce the value of the fleece for weaving, and at the Gobelins manufactory they seriously interfered with uniform and perfect dyeing (Delafond).

As in all cases of violent local irritation and infection, the subjacent lymph glands may become enlarged and tender, and suppurating and septic foci may form in distant organs.

Left to itself the disease tends to constant advance, with encreasing emaciation and debility, and leading to marasmus and death. It makes less progress in the open summer pasture than in close, warm buildings, but more in the very young or in animals that are emaciated and weak than in those that are in the prime of life, and in the fine-wooled than in the long-wooled. In exceptional cases, it is claimed that long-wooled sheep, in middle age, and in high condition, on rich pastures will get well spontaneously, but in any case they respond much more readily to judicious treatment than do others. This tendency of the disease to stand still or even abate somewhat when at pasturage, accounts partly for the partial or complete neglect of scabby sheep kept on open ranges and rarely or never shut up indoors.

Diagnosis must usually rest on the inveterate itching, the seat of the affection (neck, back, loins, croup, etc.), the accumulation of debris in the deeper layers of wool, and finally on the discovery of the acarus. By raising the scabs from among the wool around the margins of the bare spots, and placing them on black paper or on a glass slide in the sunshine or in a warm room, their presence is quickly manifested by a movement of the scabs, and the acarus can be detected with the aid of a hand lens, or a low power of the microscope. Or clear up the scales with a 10% solution of potash and examine with the microscope.

Treatment. One of the first considerations is to sustain or improve the general health, and keep the patient as far as possible in the open air. A rich succulent pasture is to be furnished when possible. When this is impracticable as in the winter season, a comfortable, roomy, airy shelter, with ample space to run in the sunshine is desirable. No less so is nourishing food to obviate that low health or debility which so much conduces to the multiplication of the psoroptes and the sinking of the sheep below the standard of successful resistance.

In applying acaricides to sheep the mode of application is largely determined by the thickness of the fleece. If in the warm season, the sheep should be shorn, the affected animals in such a case being kept scrupulously apart from the sound ones. If only one or two sheep are affected a careful watch and a thorough local application of any one of the antipsoric remedies may succeed. When more generally affected the only safe course is to treat the entire flock, and for this there have been different methods followed in different countries. These may be divided into **smearing, pouring** and **bathing.** *Smearing* or *pouring* implies cheap labor to make it economical, yet it may be made to stimulate and improve the wool so as to partly pay for the extra outlay. **Baths** being more rapidly applied and more economical are usually adopted when large numbers of sheep have to be treated. With either method, the scabs that accummulate in old standing cases should be first broken up so as to allow of an universal penetration of the medicinal agent. The bare surface may be well scraped with a wooden spatula, using the edge and flat alternately until the scabs are thoroughly broken up (Delafond). The skin should be first wetted with some antipsoric application and the scraping should be done outside of the fold and any highway or enclosure to which sheep have access. Another method is to plunge the sheep for two minutes in a warm (80°F.) soapy bath (soap 2 lbs. water 22 gallons) and to brush or break up with the fingers any scabs that may be present. This is, however, usually combined with the antipsoric bath, the immersion being kept up for 3 minutes. To avoid indigestion the dressing should not be made until four or five hours after a full meal.

Smearing. In exposed hilly regions, like the Highlands of Scotland, smearing is largely employed, as it at the same time protects the dorsal part of the fleece and skin from the *rain rot* which is so injurious in central and northern Europe. The old standard *salve* was made with 6 lbs. butter and 1 gallon wood tar. As this reddens and depreciates the wool it may be replaced by 18 lbs. each of crude turpentine (white pine gum) and lard, and ½ gallon of sweet oil. Or 18 lbs. of crude turpentine and 22 lbs. castor oil. The last is to be preferred as stimulating and improving the growth of wool. In case of *scab* its application is to be preceded by the scraping referred to above, or the wool must be

parted from head to tail at intervals of two inches and the *salve* rubbed in until all scabs are broken up and the surface thoroughly covered. Applied in the absence of *scab* as a simple protection and general parasiticide the wool is parted to the skin in lines four inches apart and the salve is rubbed in along the whole length of the line.

Pouring. For pouring, the following mixture is appropriate: decoction of 1 lb. of tobacco in 20 pints of water, soft soap 1 lb., sulphur ¼ lb., oil of tar 40 ozs. This suffices for 20 sheep. The first three agents are mixed, then one pint of the mixture is taken in an oiler, 2 ozs. of oil of tar added and the compound used on a single sheep. The wool is parted from head to tail, as in salving and the liquid poured on the skin along the line, and in cases of *scab* well rubbed in. In the absence of *scab* the finger is only drawn along the line of liquid so as to press it into the roots of the adjacent wool. An important element in *pouring* is to keep the oiler continually shaking so as to prevent the oil of tar from separating from the mass of the liquid, and irritating the one place on which it is applied.

Among other pouring preparations may be named tobacco 1 lb. black hellebore 1½ lbs., water 20 quarts.

Dipping. For large flocks dips have virtually superseded both of the above methods. For a length of time the standard dips were arsenical or mercurial.

As an example of an **arsenical dip** the following may be given: Arsenious acid (white arsenic) 20 lbs., soda ash 20 lbs., sulphur 2 ozs., soft soap 4 lbs. These are dissolved in 4 gallons of boiling water, then enough cool water is added to make a total of 50 gallons, which will suffice for 50 sheep. Some add a little aloes to make the liquid bitter and unpalatable and to give a color which will distinguish it at once from ordinary drinking water.

A great variety of apparatus are in use but a simple bath for a small flock may be made of a wooden box (waterproof) four feet long at the bottom, two feet wide and three feet deep, and having an inclined plane extending up from the bottom at each end and furnished with ramps to give foothold. At one end is a yard holding the sheep waiting to be dipped, and from the other is continued a slightly inclined wooden enclosure for the dipped sheep to receive the drippings from their fleeces and run them

back into the bath. Two men dip a sheep in the bath back downward, and hold by fore and hind limbs and neck. The greatest care is taken to prevent the head getting under the surface, as a single swallow of the liquid would prove fatal. For three minutes the compound is worked into the wool and skin until all parts are thoroughly saturated. This is favored by the maintenance of a temperature of 80° F. or over. The sheep is then laid on the inclined plane, and the wool wrung to force out the greater part of the liquid, which flows back into the bath. It is left on the sloping wooden platform to further drip, and is finally turned into a bare yard, without a trace of grass or other food on the ground, to dry. If turned on grass the drippings on the blades render them poisonous. Even after the sheep have dried off, a sudden shower will wash off enough arsenic upon the grass to poison animals eating it, so that for some days, the sheep must be promptly folded in case of rain. Another danger is that, in a dearth of water especially, the sheep may suck the liquid from each others fleeces and so poison themselves. Any of the material left over in the bath proves an additional source of danger. Sheep and other domestic animals have been known to drink this with fatal effect. But it is difficult to safely dispose of it. Poured out on the ground it may be licked for the saline taste ; run into streams it poisons them ; poured into a pit it may leach into nearby wells or watercourses. A pit dug at a long distance from either is about the only safe place to put it.

There has been much apprehension of the absorption of arsenic through the skin, and on the continent of Europe iron salts are added to lessen the danger. Stephenson Macadam, however, long ago demonstrated on sheep and his own person that there is practically no danger from absorption of arsenic through the sound skin. For 24 hours after a prolonged immersion there was not a trace of arsenic found in the urine. Later experiments at Melun have thoroughly endorsed this position. The arsenical baths are very effective and when used with extreme precaution they can be made perfectly safe. Yet when used generally in enormous quantities it follows too often that the necessary vigilance is relaxed, and heavy losses ensue. In 1858 on one farm in Northumberland 850 sheep, 5 horses, 1 ox, and a number of fowls were poisoned by an arsenical bath. The sheep alone

passed through the bath. As a general dip therefore, in all sorts of hands, it cannot be recommended as safe. It belongs to the same class with the dustings and sprayings of plants with Paris green and Bordeaux mixture, which have so greatly encreased the mortality of farm animals in recent years.

Mercurial dips have also been widely used and are to be condemned even more than arsenical, the agent being absorbed through the skin, exposing the sheep in some instances to salivation and in others to fatal congestions of the lungs and other internal organs when the subjects have been exposed to cold. The bath is usually a watery solution of corrosive sublimate varying from 1 in 500 to 1 in 50.

Lime and Sulphur Dips are devoid of danger to life and are very effective in dealing with scab and other insect invasions of the skin. They are objected to as tending to dry the wool and render it brittle and there is a grain of truth in the charge. It is only, however, the free lime in the dip that operates in this way and therefore if it is made with an excess of sulphur and boiled long enough to transform all the lime into the sulphur compound the evil is reduced to a minimum. Again, when applied, as it usually is immediately after shearing, the whole objection falls to the ground. The combining proportions of sulphur and calcium are as 3 to 4, but as an excess of sulphur is an advantage, and as the volatile sulphur is liable to be lost in part in the preparation, it is best to use that in considerable excess. The Victorian preparation of 20 lbs. of sulphur to 10 lbs. of quick lime and 100 gallons of water is a commendable mixture. The sulphur and lime are *boiled for at least two hours* in 25 gallons of water, fresh water being added as required. It is then diluted to make 100 gallons, and left until all sediment is thrown down. The clear liquid only should be taken and used in the bath. Like the other dips it should be used warm.

If it is desired, a tobacco decoction can be added, but this is not necessary to make it effectual.

Potassium Sulphide makes an effectual acaricide. Gillette used 4½ lbs. potash lye, 16 lbs. sulphur and 100 gallons of water, Long and thorough boiling is as important here as in the lime and sulphur preparation.

Carbolic Acid Dips may be made with 2 to 5 per cent. of

carbolic acid which, as seen from our table, is a potent acaricide. The drawbacks are various : it reddens and shrivels the wool ; it is volatile and readily absorbed so that it gives no permanent protection and in a few days a new stock of acari may be taken from lairs and rubbing places ; it is very soluble and easily washed off by rains or carried in sweat.

Tobacco Dips. Of non-mineral baths tobacco is certainly one of the best. Tobacco is a slow acaricide but it is non-volatile and remains for a length of time on the wool and skin, protecting the sheep against any fresh arrivals of the psoroptes. The sheep is very insusceptible to nausea, and unless the application to the skin is very strong, or unless a considerable amount is swallowed there is practically no danger of poisoning. Finally, tobacco does not deteriorate but tends rather to improve the wool. The tobacco may be used in the proportion of 1 or even 2 parts to 20 : (5 or 10 lbs. to 100 gallons water). It may be steeped for 24 hours, and then brought to the boiling point, cooled to 80° F, strained and used. It must of course be well worked into the skin, with the breaking up of the scabs, and in inveterate cases may require to be repeated once or twice at intervals of ten days.

Tobacco and Sulphur Dips. This combination is one of the most effective dips known, yet one of the safest. Ten pounds each of tobacco and sulphur are added to 60 gallons of water. The tobacco is steeped for 24 hours in water, then raised to the boiling point, then allowed to cool for twelve hours. It may now be strained and pressed, the liquor mixed with the sulphur made into a gruel-like mixture by rubbing up in water, diluted with water to make the required amount, and thoroughly mixed by stirring. In Australia hundreds of thousands of scabby sheep, many cases of two years standing, have been cured in two dressings without the destruction of any fences or other objects used for rubbing. It improves rather than deteriorates the wool and does not affect the health even temporarily.

Thibetan shepherds attach a bag of borax on the back of each sheep : (Kipling in Miracle of Purum Bhagat, Second Jungle Book). Probably as an insecticide.

Coal Tar Dips. A number of dips can be made from the coal tar products, preference being given to the heavier oils which volatilize less readily and are therefore more permanent in their

effects. Nearly all of them are rendered soluble in water by a large admixture of alkalies and alkaline salts and are, therefore, easily washed off, besides tending more or less to render the wool brittle or to irritate the tender skin. In place of naming the various coal tar sheep dips, the composition of which is secret and may, therefore, be altered at will by the manufacturer it seems better to give some of the more common chemical coal tar products and indicate the strength in which each may be used.

The familiar *creolin* may be used in the ratio of 1½ pints to 50 gallons of water. *Lysol*, 2 quarts to 50 gallons. *Beta-Naphthol*, 2 quarts to 50 gallons hot water. *Aseptol*, 2 quarts to 50 gallons. *Monochloronaphthol*, 2 quarts to 50 gallons. *Cresyl*, 2 quarts to 50 gallons. Tobacco or other agents may be added at will.

Impure and complex products of coal tar, containing a variety of different chemical compounds, and rendered soluble or capable of being emulsionized by the addition of soap and soda ash make good and cheap sheep dips. Thus three pints each of oil of tar, and of the heavy oils (dead oil) drawn from coal tar can be added to 50 gallons of water as a dip.

With any form of dip it should be repeated in fourteen days to destroy any acari that have been hatched out in the interval. This may be repeated as often as may be necessary.

Prevention. As psoroptic scabies is one of the most infective of diseases, causing the most extensive losses, and is, in its initial stages, one of the most obscure, it becomes the more necessary to place it under the most rigid sanitary rules.

When the disease is found in a flock, the fact should be at once reported, under a penalty for failure, and the flock quarantined in a well fenced field or fold apart from all other sheep or goats, and treated by one of the methods above described until all trace of the disease has disappeared. The place where they are kept and where they have been must be thoroughly cleaned and kept clean, and any manure, litter, and left-over fodder, as well as the place itself, freely sprinkled with a strong solution of some acaricide. If placed where no animals can have access to them mercuric chloride may be used, but otherwise sulphuric acid solution ; carbolic acid, 5 per cent.; creolin, 5 per cent.; tar water or solution of chloride of lime, 4 per cent. The floor, walls, racks, troughs, fences, rubbing posts, stones, and all woodwork

should be washed with scalding water or a solution of caustic potash and then covered with a solution of one of the acaricides.

The disposal to others of animals affected with scabies, or their exposure in any unfenced or public place should be made and dealt with as a misdemeanor. The disposal or exposure of undisinfected hides or wool taken from the affected should be forbidden under penalty. Any damage done to other flocks by such sale or exposure should further entail damages on the person responsible for such sale or exposure.

When sheep that have been shipped by rail or through any other channel, or that have been exposed in market, fair, or other public place, are found to be infested, the original shipper should be held responsible, and all cars or other conveyances, highways, yards, alleys, loading banks, shutes, folds, houses, pens, fields and any other place that has been occupied by them should be closed as infested places until they have been thoroughly disinfected, or until time has been allowed for the death of the parasite. The owners of sheep or goats that have passed through such places in the interval should be notified by telegraph, together with the authorities in the locality where they may be, to see that they are subjected to antipsoric baths, and detained until they are proved sound. The disinfection of railway rolling stock, yards, etc., and of infested stockyards is imperative, and if the cars can no longer be identified, then all that have passed through the particular destination in the time involved should be dealt with as probably infested.

In America state rights and limits form a serious bar to effective measures for the extermination of this disease. The Bureau of Animal Industry has acted energetically in the matter, applying the law which makes it illegal for shippers or transportation companies to move from state to state by conveyance, public or private, or by highway, any sheep affected with *scab*, prosecuting said shippers and transportation companies, enjoining the detention, cleaning and saturation with a carbolic acid solution (5:100) of all cars, boats, or other vehicles, and of all places of detention or delivery in which such sheep have been placed. The general penalty of $100 fine or one year's imprisonment or both for each violation is applicable in this case.

Store sheep with scab are detained and treated, fat sheep in the

early stages can be slaughtered. Advanced cases are poor and unfit for mutton, and are sent to rendering works.

The following drawbacks are still met; transportation companies are imposed on by owners and shippers who represent flocks as sound; and stock companies use ineffective baths, or detain the sheep too short a period and fail to dip often enough to make the dressing effective. Owners therefore should accompany the shipment, by a certificate of soundness, and, at places of detention, the inspector of the bureau should personally see the dipping, and give a certificate for movement only when the disease has been eradicated.

Owners shipping store sheep would consult their own interest by passing them through an effective dip just before shipment, as this would prevent the attack of the parasite even if it were met with in transit, and obviate the conveyance of the parasite on their fleeces to infest cars and other objects and places. This is unsuited to fat sheep going to slaughter and these are accordingly more liable to infest objects in transit, and being more slightly affected are more liable to be overlooked.

Similar measures should be adopted by a state, in case of the movement of sheep within its own borders. To do effective work the Federal and State Laws and inspectors must work harmoniously, in one line, to one end. Efficient work should eradicate the parasite from the United States, and with it one of the worst drains on the sheep industry. Drawbacks unfortunately are often to be met within official ranks.

SYMBIOTIC ACARIASIS (SCABIES) IN SHEEP. FOOT SCAB.

Symbiotes scabei v. ovis: Like that of horse and ox, but does not live permanently on these. Most serious in winter; may not show, though present in summer. *Symptoms:* Redness, itching, swelling, scurf of the lower parts of the limbs, stamping, rubbing, gnawing, cracks, bleeding sores; acarus under crusts, not under epidermis. Lesions may extend to the fore limbs, arms and thighs; has been taken for foot-rot. *Treatment:* Any of the anti-psoric liniments, ointments or dips; even pure glycerine, bland oil, or vaseline.

This is caused by the **Symbiotes (Chorioptes, Dermatophagus) Scabei var. Ovis,** and presents the same morphological

characters as the symbiotes of the horse and ox. The disease is rare and spreads slowly from sheep to sheep, showing itself especially in winter, in folded sheep, and improving virtually to apparent recovery in the hot weather when the symbiotes can live in the hair, feeding on the secretions and without biting the skin. It is on this account that German shepherds attribute the disease to dry winter feeding and especially to the abundance of salt consumed. The real cause is that the symbiotes is driven inward by the cold to bite the skin and live under the scabs and scurf where it causes intense irritation. It never hollows out galleries under the epidermis like the sarcoptes.

Symptoms. The affection prevails in winter, causing redness of the skin in the pasterns and lower parts of the limbs, with abundant scaly desquamation and the formation of crusts. The attendant itching may be violent, causing stamping, rubbing and gnawing which induce scabbing, cracking, abrasions and even oozing of blood. The symbiote may be found in and under the crusts and being smaller than the psoroptes, a more powerful lens, or object glass may be required to discover it. The lesions are at first confined to the hind limbs, but later extend to the fore as well. In bad cases the acari may crowd upward on to the arms and thighs, but practically never invade the body :—a most important diagnostic symptom. Confined for a length of time to the region of the hoof, the disease has been confounded with foot-rot, hence the necessity of a careful search for the acarus.

Treatment is very simple and effective. Any of the anti-psoric liniments or dips, repeatedly applied to the affected part will destroy the parasite. In England, Goodall found that glycerine alone was successful and doubtless a bland oil or vaseline freely applied so as to block the breathing orifices would be equally effective.

SARCOPTIC ACARIASIS (SCABIES) IN GOATS.

In Asiatic, African (dwarf) and Swiss goats. Has been transferred to face of sheep, to man, horse, ox and pig, but not to fine-wooled sheep, dog nor rabbit. Sarcoptes scabei v. Capræ, distinguished by its host. *Symptoms:* Begins on face but extends to head, ears, neck, trunk, udder and limbs;

redness, papules, scales, scabs, friable scurf, with scratching, rubbing, abrasions, sores, pustules, inappetence, wasting, marasmus. *Treatment:* As for sheep, but especially clipping and anti-psoric liniments and ointments. *Otacariasis:* Psoroptes in auditory meatus of goats in Pyrenees. Seemed harmless. *Treatment:* Glycerine or oil in ear, with or without tobacco decoction. *Symbiotic Acariasis in Goats:* In Angora goats, attacks pasterns, or neck, shoulders, back, loins, rump. *Symptoms:* Redness, papular eruption, exudate, matting hair in tufts, or forming crusts, skin, thick, corrugated, glands swollen; extension slow. Acarus like that of sheep, etc., but has longer rostrum and limbs, and two spathe-like prolongations on abdominal lobes. *Treatment*: Clip; soften and remove crusts; apply anti-psoric dressings.

This has been especially noticed in goats brought from Thibet, Persia (Henderson), Kartoum, Africa (Müller), and N. Africa (Roloff). It appears to be common to goats of different breeds, but has been thought to be especially obnoxious to those of Asia, Africa (dwarf goat) and Switzerland.

Pathogenesis. The fat tailed sheep has been found affected and Railliet has transferred the acarus from the goat to the face of European sheep, so that the acarus has been supposed to be identical with or closely allied to that of *Black nose* (**Sarcoptes Scabei var. Ovis**). It has also been successfully transferred to the horse (Wallraff), the human being (Henderson), to cattle and pigs (Wallraff). Müller failed to convey the disease to sheep with long or dense or greasy wool (to any indeed but those with short or scanty wool—Somali, Fat-tailed). He also failed with pig, dog, ass and rabbit.

The parasite, **Sarcoptes Scabei var. Capræ,** resembles the other sarcoptes already mentioned and is distinguished by the animal which it prefers as a host.

Symptoms. The affection may begin on the face as in sheep, but differs from black nose in tending to become generalized, on the head, ears, neck, trunk, udder and finally the limbs. It appears with redness and minute papules, with an excess of dandruff, and exudation which concretes in a thin friable scurf, or, under the energetic scratching, rubbing, and biting, into thick scabs with, at intervals, cracks, abrasions, raw sores, and pustules. The hair drops from the affected parts. The intolerable itching, unrest, and impairment of feeding, digestion and assimilation determine a rapid loss of condition and numbers of goats perish.

Treatment is the same as for sheep, but as the goat is intractable in the bath it is best to resort to liniments or ointments after having clipped the hair and softened and removed the scabs.

Psoroptic Acariasis (Scabies) in the Ear of Goats: Otacariasis. This affection has been seen in two goats from the Western Pyrenees (Pesas and Morot). There appeared to be no local irritation, but exammination of the cerumen revealed the presence of the acarus which has almost the same size and form as those of the larger animals. It has been suggested that investigation may reveal their presence in many goats. If found to cause irritation, injection of glycerine, with or without tobacco should destroy them.

Symbiotic Scabies (Acariasis) in Goats. This has been described in Angora goats and differs from the symbiotic acariasis of horse, ox and sheep, in that it does not show the same preference for the lower parts of the limbs. In one outbreak described by Mollereau the disease was, however, confined to one hind pastern which was encrusted with scabs and shreds of straw, and attended by extensive exudation or œdema, and even commencing gangrene. The symbiotes swarmed beneath the scabs. In Delafond's cases it attacked the back of the ears, sides of the neck, shoulders, back and loins, and the root of the tail, and generally avoided the lower parts of the trunk. There is at first redness with papular eruption and exudate which concretes into hard masses, matting the hair in tufts which are duly shed, or forming thick, hard yellowish scales or plates, beneath which the skin is thickened and corrugated. The subjacent lymph glands become swollen. Beneath the crusts and especially the recent ones the symbiotes are found in numbers. The hair has lost its lustre and elasticity and individual fibres show inequalities in thickness from root to point. It is matted with scabs and debris near the roots and proves unfit for combing.

The disease makes a slow extension, and a lapse of months may be necessary to show marked advance.

The acarus, **symbiotes communis var. capræ**, does not differ materially in appearance from the symbiotes of horse and ox. It can be readily distinguished from the sarcoptes of the horse and ox, by the greater length of the rostrum and limbs, and by the presence on the adult male of the two posterior abdominal lobes, bearing the broad spathe-like prolongations.

Treatment is by the usual anti-psoric liniments or ointments after clipping and the softening and removal of the scabs by soap suds and brush, with or without previous oiling. Delafond succeeded with simple alkaline baths: Ten pounds of carbonate of potass or soda in 22 gallons of water.

SARCOPTIC SCABIES (ACARIASIS) IN SWINE.

Sarcoptes Scabei v. Suis: Larger than S. of horse; another variety like the S. minor of the cat. *Susceptible:* Man and dog for 8 or 10 days at least, High bred English swine most subject. *Symptoms:* Usually starts where skin is thin; ears, eyelids, axilla. thigh, and extends to whole body. Violent itching, rubbing, fine red papules, puckering, erect bristles, pea-like elevations, scales, leathery covering, abrasions, sores, ulcerations, anæmia, unthrift. Acarus beneath crust removed in sunshine or warm room; visible to eye. *Treatment:* Remove scurf with warm soapsuds and brush, then sulphur ointment, calcium sulphide solution, chloride of lime, or other anti-psoric agent. Disinfect the pen, or abandon it.

The pig, like man, suffers from the sarcoptic scabies only.

Sarcoptes Scabei var. Suis (S. Squamiferus) resembles that of horse and ox, but is somewhat larger (ovigerous female .40 to .50 mm. long; male .25 to .35 mm.) This lives also on the dog, and Roloff sought to identify it with the *sarcoptes capræ* of the dwarf goat of Kartoum. Guzzoni identified a smaller variety on swine, the female being but .29 mm. long and the male but .18 mm. This approximates in size to the **sarcoptes minor** of the cat. The pig may therefore be said to harbor the largest and nearly the smallest *sarcoptes scabei.*

Animals Susceptible. Transferred to man the large sarcoptes produces intense irritation which lasts about five days (Bateman, etc.), ten days (Gerlach), or even indefinitely (Delafond). In the dog it caused a violent eruption in forty-eight hours, which, however, had subsided by the eighth day.

In pigs the improved English breeds suffer most, and in some instances common breeds have escaped, though running with the affected improved animals (Neumann).

Symptoms. The disease may start at any point where the acarus is placed, but by preference where the skin is thin, the roots, back, and inside of the ears, the eyelids, the axilla, the

inner surface of the thighs, and gradually extend to the rest of the body. There is violent itching and rubbing, and a close examination may detect some red, closely set papules. The skin at such points is wrinkled and the bristles stand erect, and later are loosened and shed, lying on the surface in matted tufts. Behind the ears or elsewhere the papules may become projecting tubercles like peas or beans, red and angry or covered by a brownish scab. Again the thickened epidermis and exudate form a hard leathery covering with suppuration going on beneath, and perhaps an inch in thickness. Under the desperate rubbing the quick is exposed at intervals with suppuration and ulceration. The advance of the disease is slow, but from the first there is loss of condition, which merges into marasmus and may prove fatal.

Diagnosis is completed by the discovery of the sarcoptes, which is found beneath the scurf or crust and may not be found at all in the surface layers. The pig should be placed in a warm room or in the sunshine to tempt the mite into activity, and the deepest layers of the cuticle or scab taken for examination. Being large the acarus may be detected with the naked eye, but better with a lens or low power of the microscope.

Treatmeut. The first step is to remove the scurf and scab with warm soap suds and brush, preceded in bad cases by an inunction of lard for twenty-four hours or longer. This may be followed by any of the anti-psoric liniments or ointments, which may be reapplied every day until a cure is established. Tobacco decoction (1 pound to 1 gallon), or black hellebore (½ pound to 1 gallon), or stavesacre (½ pound to 1 gallon) proves effective, but may cause vomiting. Sulphur 200 parts, carbonate of potassa 100 parts, and lard 800 parts, is a slow but safe non-nauseating application; so is calcium sulphide solution. If a more rapid agent is wanted, a little tar, oil of tar, oil of turpentine, or carbolic acid may be added.

In any case the pen and yard must be purified. A thorough washing with hot water, followed by a saturation with a 5 per cent solution of carbolic acid, or a solution of chloride of lime (½ lb. to 1 gallon) will suffice. The ground after it has been scraped may be covered with freshly burned quicklime.

SARCOPTIC SCABIES OF THE RABBIT.

Sarcoptic acariasis and commensals in rabbit. S. Minor: On rabbit, and slightly varying in size, on brown rat, cat and coati. *S. Minor v. Cuniculi:* Smaller than sarcoptes of other domestic mammals; forms one spacious nest under cuticle, not channels. Attacks nose, lips, eyelids and forehead, paws to elbows and hocks, rarely the intermaxilla, jaws and neck. *Symptoms:* Extreme itching and scratching, depilation, detached, ragged fur, bald spots, gray crusts, intervening cracks and sores; skin thickened, rigid, closed eyelids, nose, lips, anæmia, marasmus. Young suffer most. Acarus found on inner side of crusts. *Treatment:* Clip; dress with sulphur and sodium carbonate ointment. Disinfect hutches; burn litter, fodder and manure.

This seems to be the one form of scabies or acariasis of the skin in rabbits. The acariasis of the external auditory canal is of course excepted. It must be noted further that the rabbit acts as host to other acari—*Gamasus pteroptoides*, *Cheyletus parasitivorus*, and *Listrophorus gibbus*—but these represent commensals and not injurious parasites.

Sarcoptes Minor; The Dwarf Sarcoptes is common to the rabbit, brown rat, cat and coati. It does not follow that it may be transferred easily from one genus to the other. Experiments by Gerlach and others along this line have failed. Even the size varies materially. Thus it is found on rabbit and cat,—female .16 to .25 mm. long, and male .12 to .18 mm., whereas on the rat and coati it may be nearly double this size. With the general appearance of the sarcoptes it is marked out mainly by its small size and according to Megnin by the spacious nest which the female forms under the cuticle instead of a linear channel. The variety infesting the rabbit is named accordingly; **Sarcoptes Minor var. Cuniculi.**

Symtoms. The disease appears on the nose and lips, the eyelids and forehead, and only exceptionally extends to the ears and lower jaw, the throat and neck. Both fore and hind feet suffer early on account of scratching, the disease extending up to the elbows and hocks. The itching is extreme, and the scratching and rubbing most energetic, the fur is torn out, hanging in tufts or leaving bare spots, an exudate oozes out and collects in grayish white crusts, and finally thick adherent scabs. These

stand out in isolated masses, with intervening cracks, raw and oozing, or red and bleeding. On the detaching of the scab a red raw surface is exposed. The skin is extensively thickened and, by reason of the scabs, rigid, so that lips and eyelids become immovable, vision is impaired and prehension becomes impossible and the rabbit dies of starvation. The malady is especially destructive to the young.

Diagnosis is based on the seat of the disease, the inveterate itching, the scabby eruption and loss of fur, and mainly on the discovery of the acarus. This is easily found on the inner side of the scurf or scab when raised. The harmless commensal acari cause no local irritation and even if present in connection with scabs are not found on their inner surface.

Treatment requires removal of the fur, the softening of the scabs with soap, their removal, and then repeated dressings with the ointment of sulphur and carbonate of soda.

The hutches must be carefully disinfected, the litter being removed and burned and the manure and left over fodder buried.

PSOROPTIC ACARIASIS OF THE AUDITORY CANAL IN RABBITS. OTACARIASIS.

Otacariasis by psoroptes communis v. cuniculi. Distribution: Twenty-five per cent. at Paris. Horse susceptible. *Symptoms:* Itching, scratching of concha, tossing head, swelling, tenderness of ear, with yellow debris and many acari; ears lop, inappetence, wasting, diarrhœa, abortion, drowsiness, vertigo, paralysis, wry-neck, fits. *Treatment:* Syringe with soapsuds and apply benzine in oil, phenol in glycerine, or sulphur ointment. Disinfect hutches. Keep from mangy horses or their stables.

This is an invasion of the inner surface of the concha and the external auditory canal by the **Psoroptes Communis var. Cuniculi.** Being large (female .68 mm., male .35 mm. long) they may be detected by the naked eye, among the debris, or still better with a lens. Delafond found that 25 per cent. of rabbits held by the Parisian dealers suffered in this way, and the affection is common elsewhere. Mathieu caused papules on the horse by transferring the acarus from the rabbit's ear, Cagny saw horses attacked from living with affected rabbits, and Cadeac saw rabbits suffer when placed in the same stable with mangy (psoroptic)

horses. It remains uncertain whether the disease so produced would prove temporary or permanent.

Symptoms. The affection is confined to the interior of the conchal cartilage, though it may extend through the annular cartilage, and even through the tympanic membrane. It begins at the root of the concha as a slight exudation, with intolerable itching, tossing of the head and ears and scratching them violently with the hind feet. The ear is sensitive to sneezing. After a few weeks it is thickened, hard and painful, and is filled by a yellowish, granular, foul debris in which the acari are found in abundance. The ears now lop habitually and their interior, including the lining membrane of the canal, is raw, swollen and sore. The appetite fails, emaciation sets in, diarrhœa, abortion, failure to breed, and in some cases drowsiness, vertigo, paralysis, epilepsy and torticollis appear. In these cases the middle or internal ear may have been invaded if not by the acari yet by the extending inflammation. The vertigo is to be referred to the semicircular canals and the epilepsy to the reflex irritation from the seat of irritation, like that which Brown-Sequard induced in mutilated Guinea-pigs.

Treatment. Wash out the ear with castile soap and warm water, then fill the annular cartilage and smear the concha with a mixture in equal parts of olive oil and benzine and repeat the application daily. A 2 per cent. solution of carbolic acid in glycerine does well and is somewhat more permanent, as is a similar solution of oil of tar or cade oil. A solution of tobacco or a sulphur ointment is effective and devoid of irritant properties.

The usual methods of purifying the hutch and surroundings must be resorted to. Again horses with psoroptic mange must be carefully excluded and the places where they have been, their harness and other belongings must be treated. Whether the psoroptes derived from the horse can live indefinitely in the ear of the rabbit or not, it is certain that constant accessions of the parasite will keep up the affection continuously in the rodent.

SARCOPTIC SCABIES (ACARIASIS) IN CAMEL AND DROMEDARY.

Common in East, transmitted through khans. *S. Scabei v. Cameli. Susceptible:* Dromedary, llama, giraffe, antelope, and even man. *Accessory causes:* Poverty, weakness, filth, fatigue, using same lairs and trappings. *Symptoms:* Begins on thin skin, anus, perineum, groin, sheath, mammæ, and extends generally. Intense itching, rubbing, biting, scratching, papules, skin thick, rigid, wrinkled, cracked, abraded, scabbed, ulcerated, weakness, emaciation. Secondary infections, lymphadenitis, stocking, arthritis, etc. *Treatment:* Clip, apply green soap and lard. *Prevention:* Cleanliness, grooming, avoidance of infected places and animals, anti-psoric ointments.

This has been long known in the East, the transmission being especially favored by the aggregation of the animals in herds, and their camping in the same Khan or on the same ground in succession.

The acarus is **Sarcoptes Scabei var. Cameli** and it has less evident markings on the integument than have other varieties. The female is .44 mm. and the male .24 mm. long.

Animals susceptible. It attacks indifferently the llama, giraffe and antelope bubalis. Its transmission to man from newly-arrived camels has been attested by Frank, Straus-Durkheim, Hamon and Biett, and its prevalence in Arabs handling the diseased camels is familiar (Palgrave, Vallon, Gourdon, etc.). In Senegal a similar skin disease attacks the negroes who handle diseased dromedaries, (Berenger-Feraud, Carpot, Blanchard) but the acarus has not been identified. Camel and horse contract the disease from each other (Barry).

Accessory Causes: Low condition, weakness, filth, using the same lairs in succession, or the same trappings are especially to be noted. Fatiguing travel from place to place reduces the resisting power and encreases the opportunity for infestment.

Symptoms. The thin parts of the skin, anus, vulva, perineum, groin, sheath, mammæ, inside of thighs and elbows, interdigital space, and abdomen are usually first attacked, but the acarus gradually invades the entire body. There is intense itching, manifested by constant rubbing, nibbling, biting and scratching so that the animal may be all but uncontrollable, papules (⅓ inch) arise, the hair is broken, twisted and rubbed out, and the

skin is thickened, indurated, corrugated, cracked, fissured and abraded. The exudate concretes in thick, hard scabs, and the discharge is offensive. The disease advances with great rapidity, with increasing emaciation and debility and tends to marasmus and death. The abundant cutaneous and subcutaneous exudate, forms a fertile field for other infections and lymphangitis, swelling or suppuration of the adjacent lymph glands, infiltration and swelling of the hind limbs, or of the affected areas of the body, and even arthritis and other internal infections ensue. Biett's cases in man had gastro-intestinal inflammation and anasarca.

Treatment. Clip the whole skin, wash with soap suds then apply a mixture of tar and lard equal parts, or the lard may be replaced by green soap, or any bland oil. A thorough and repeated application of any of the efficient acaricides would doubtless succeed.

Prevention consists in avoiding the usual causes of contamination, of weakness, and debility, in good grooming, and in an inunction with an anti-psoric ointment several times a year. Crude tar is used, but occasionaly causes asphyxia.

SARCOPTIC SCABIES. ACARIASIS IN THE DOG. MANGE.

Sarcoptic Scabies in dog; two species of acari: *S. Scabei v. Canis:* 30 mm. long, communicable to man and probably to horse and pig, and *S. Scabei v. Lupi* on wolf, dog and man (crusted mange, Norwegian itch). Harbors temporarily *S. Minor v. Felis, S. Scabei v. Suis,* and *Trombidium larva. Symptoms:* Begins on head, eyes, muzzle, ears, from prey, paws, breast, belly, back, rump; papules, vesicles, intense itching, licking, rubbing, biting, scratching, abrasions, sores, crusts, cutaneous thickening, wrinkling, pustulation, depilation, inappetence, emaciation, debility. Diagnosis: Intense itching, rapid spread, discovery of acarus. *Treatment:* Clip; green soap, alcohol and phenol, then acaricides; naphthalin, vaselin, lavender oil, sulphur ointment, Peru balsam ointment. Burn litter; clean, scald kennel; whitewash with acaricide. *Prevention:* Seclusion of mangy dogs; exclude from shows, hunts, etc. Scald clothing.

The dog, like the pig, harbors two different sarcoptes which give rise to what might be technically held to be two diseases, *Common Mange* and the *Mange of the Wolf.* The acari are:

1. **Sarcoptes Scabei var. Canis,** ovigerous female .30 mm., male .20 mm. long. Zurn claims that this may cause scabies in

horse and pig as it has often done in man (Chabert, Grognier, Viborg, Biett, Delafond, Gerlach, Fröhner, etc.)

2. **Sarcoptes Scabei var. Lupi**, a very much larger variety found on wolves and dogs, was identified by Fuerstenberg as the basis of the inveterate *Norwegian itch* of man, but Hebra denies the correctness of this. It seems clear, however, that it may live on man. In keeping with its larger size it produces more extensive local lessions, with a more abundant exudate, which determines what is known as crusted mange.

Still two other sarcoptes can live, at least temporarily, on the dog, **Sarcoptes Minor var. Felis**, and **Sarcoptes Scabei var. Suis** already described. Finally the **trombidium** 6 legged larva attacks the dog on paws, limbs, abdomen, nose and elsewhere, giving an appearance of mange which, however, shows in summer only and recovers in a day or two if the victim is shut indoors.

Symptoms. The common sarcoptic scabies habitually starts about the head, (muzzle, eyelids, ears) suggesting that it may have been contracted by biting or smelling an infested animal. The early implication of the paws, breast, abdomen, back and rump is similarly suggestive. On parts sparsely covered by hair, it shows minute red points, soon enlarging to papules as large as a lentil or pea, and at times crowned by a vesicle. This is attended by insupportable itching, aggravated by a warm place or covering, and manifested by restless movement, biting, scratching and rubbing, and by movements of the hind foot and legs when the parts are handled or gently rubbed. Under this constant friction, redness, congestion and swelling spread over the skin between the papules, and the resulting abrasions, ruptured vesicles and open ends of the burrows of the sarcoptes exude a serous liquid which concretes as crusts and scabs, grayish yellow, brown, red or of other tint. An attendant exudation into the skin and subcutaneous tissues, produces thickening, rigidity, corrugation and adhesion to the parts beneath. The exudate decomposing becomes very offensive. Pustules and other skin lesions are not uncommon. The hair is generally shed, though unlike ringworm, the bare patches still retain a few scattered hairs. The itching does not diminish with the advance of the skin lesions, but scratching, rubbing, or, if too painful, licking is incessant. The

general health suffers, appetite is impaired, and under the constant excitement day and night the subject becomes emaciated and debilitated and may die exhausted in two or three months.

Diagnosis depends mainly on the gradual and even rapid extension of the disease from the primary centre or centres over the whole skin, on the intensity of the itching, on the extension from one dog to others living with it, and above all on the demonstration of the acarus. This last is often difficult because of the burrowing habits of the sarcoptes. The crusts should be raised and examined on their deep aspect. Or the surface of the skin may be scraped until the cuticle is removed and its deepest products examined on a piece of black paper with a lens. If still they escape observation the crusts may be steeped for one or two hours in a ten per cent. solution of caustic potash and then examined under a low power of the microscope (20 diameters). In this way the crusts are rendered quite transparent while the chitinous covering of the acarus, being unaffected, stands out clearly. The other methods of placing the patient in a warm atmosphere or in sunshine to tempt the sarcoptes to leave its burrow or that of tying the scab on the human arm may be tried.

The mange caused by *sarcoptes lupi* is mainly to be distinguished by the size of the parasite, the abundance, thickness and hardness of the scabs, and the inveterate persistency of the disease.

Treatment. The first step in long-haired dogs is universal clipping. This obviates all risk of overlooking isolated centres which are just commencing. Next the whole skin may be covered with a solution of equal parts of green potash soap and alcohol and just enough carbolic acid to give it the odor. This is washed off next day and the surface is covered with the following: Napthalin, ½ oz.; vaseline, 2½ ozs.; oil of lavender, 8 drops. This may be applied daily until a cure is established. Another very effective dressing and equally safe is sulphur, 1 oz.; carbonate of potash, ½ oz.; lard, 4 ozs. For house dogs balsam of Peru or styrax, ½ oz. to vaseline, 2 ozs., or alcohol 1 pint makes a most agreeable, if somewhat expensive, dressing, which though slow is effective. Creolin 1 in alcohol 15 is very efficient. Lysol may be used in the same proportions. Cevadilla, 1 oz.; sulphur, ½ oz.; olive oil, 8 ozs.; alum, 2 drs., is highly recommended, but like carbolic acid, tobacco, creosote, cade oil, tur-

pentine, benzine, and other preparations it necessitates a close muzzle or a leather covering on the part dressed, to avoid poisoning of the patient.

The burning of the litter, the whitewashing, or disinfection otherwise of the kennel, exercise in the open air, a varied and liberal diet and a course of tonics are important auxiliaries to the local treatment.

Prevention must be sought by the compulsory seclusion of mangy dogs, leading them only on chain, by the exclusion of all such from public gatherings of dogs as in hunting, or coursing, by the boiling in strong soda solution of all blankets, covers, rugs, bedding, etc., and by the avoidance of all handling of mangy dogs, so that the disease may not be conveyed to human beings.

SYMBIOTIC ACARIASIS OF THE EAR IN DOGS. OTACARIASIS. EPILEPTIFORM OTACARIASIS.

Otacariasis in dogs, in packs, and less often single dogs. *Symbiotes Auricularum v. Canis. Symptoms:* Shakes head, scratches ear, debris in meatus, red, raw, ulcerated patches, nervousness on exertion, yelps, runs on obstacles, falls in fit, is sullen, snappish or dull, stupid, deaf. Attacks get progressively worse. Attacks all ages. Find parasite in cerumen. *Treatment:* Syringe out with soapsuds containing 2 per cent. phenol, then inject naphthalin, ether and olive oil, or carbon bisulphide solution, or lysol.

This has been noted especially in dogs kept in packs or numbers, as packs of hounds, sporting dogs, but this is manifestly due to the facilities offered for the transmission of the parasite. It has also been seen in setters, pointers, terriers and poodles.

The essential cause of the affection is the **Symbiotes Auricularum var. Canis**, the ovigerous female of which is .46 to .50 mm. and the male .35 to .38 mm. in length.

Symptoms. The dog may show a special disposition to shake the head or scratch the ear, and the examination may show a dirty condition of the interior of the concha, and a discharge or an accumulation of scurf or debris in the external auditory canal. In some cases there is ulceration or red raw patches. Usually, however, the first symptoms noticed are the nervous ones. The dog in the kennel appears well, and he enters eagerly on a hunt, but in fifteen to thirty minutes he utters a yelp or a howl, aban-

dons the hunt and runs wildly, strikes blindly against obstacles, howls, and finally, after describing two or three circles, falls in an epileptic fit. Soon the spasms cease, but dullness remains, and hunting may or may not be resumed, according to the violence of the attack. Examination of the ear shows the accumulation of brownish ceruminous debris, in the midst of which the actively moving symbiotes may be detected.

Like all forms of acariasis the malady is progressive, the attacks come on sooner after the dog is put to work, and are more violent and prolonged, and the recovery is less perfect. The dog is sullen, snappish or timid, and stupidity and deafness are not uncommon. Death may occur during a fit.

Diagnosis. From epilepsy due to other causes, this is distinguished by the shaking of the head and rubbing of the ears, by the presence in the ear of the scaly ceruminous debris, and above all by the presence of the acarus. It is also noticeable that it attacks all ages, and not mainly the young which suffer most from verminous epilepsy, that it attacks a number of dogs kept together thereby bespeaking contagion, and that for a length of time, it is only shown when the dog is subjected to active exercise. In all cases of epilepsy however it is well to look for this parasite.

Treatment. The ear may be first cleaned and syringed out with a two per cent. solution of carbolic acid ; it may then be dried and injected with the following : naphthol 24 drops, sulphuric ether 1 dr., olive oil ½ oz.; close the opening for 10 or 15 minutes with cotton wool. As an alternate, carbon bisulphide 25 drops in alcohol, ½ oz. may be used. Or an aqueous solution of lysol (1;100). Sewell recommends ointment of nitrate of mercury 1 dr., olive oil 1 oz.

SYMBIOTIC ACARIASIS OF THE EAR IN CATS. OTACARIASIS.

Otacariasis in Cats. Symbiotes Auriculum v. felis: Itching, scratching, delirium, stupor, vertigo, convulsions: excess of cerumen in ear with acari. *Treatment:* As in dog. *Otacariasis in ferret:* Inactive, lazy, drowsy, scratches ear, excess of cerumen with acari ; tympanic and middle ear inflammation, temporal caries, meningitis. *Treatment:* As in cat.

This is due to **Symbiotes Auricularum var. Felis**, of which the ovigerous female is .45 to .47 mm., and the male .3 to .32 mm. long.

The *symptoms* are intense itching, scratching and attacks of delirum so that on different occasions the cats were killed as rabid. In other cases they became stupid, vertiginous, unable to walk, and rolled over on the side when they tried to sit up. Convulsions have not been noticed. Inside the ear is an accumulation of cerumen on and in which may be detected the moving acari as fine white or grayish points.

Treatment does not differ from that advised for the dog and need not be repeated.

SYMBIOTIC ACARIASIS OF THE EAR IN FERRETS. OTACARIASIS.

The special acarus of this affection is **Symbiotes Auricularum var. Furonis**, of which the ovigerous female is .38 to .45 mm. and the male .27 to .34 mm. in length.

The **lesions** have been observed to extend to destructive ulceration and perforation of the tympanic membrane, violent inflammation of the middle ear, caries of the temporal bone, and meningitis.

The ferret becomes inactive, lazy, drowsy, stupid and when roused scratches its ear. No acute nervous symptoms have been noticed. The excess of cerumen and the moving acari are diagnostic.

If detected early the treatment used for dog and cat is successful in the ferret.

SARCOPTIC SCABIES (ACARIARIS) IN CATS.

Sarcoptic Scabies in Cat. Sarcoptes Minor: 12 to 25 mm. as in rabbit and rat; not known to be intercommunicable. Man, horse, ox and dog susceptible. *Symptoms:* Papule on head or neck, forms vesicle, spreads, though rarely to body, hair in tufts, crusted, bald patches, scratches, abrasions, sores, closure of eyelids and nostrils, sniffing. *Diagnosis* by limited area, itching, number suffering, and presence of acarus. *Treatment:* By sulphur ointment, styrax ointment, zinc chloride solution.

This is caused by the **Dwarf Sarcoptes—Sarcoptes Minor var. Felis**, of which the ovigerous female is .16 to .25 mm. and the male .12 to .18 mm. long. It has the same size and characteristics as that of the rabbit and rat, but it has not been shown that it is communicable from one of these animals to the other, and during its prevalence on farm cats, it has not been noticed that the rats suffered. And yet the sarcoptes of the cat seems to be especially adaptable to other animals. Man has often contracted scabies from cats (Hertwig, Berthold, Marrel, Gerlach; Perroncito); so have horses (Hertwig, Megnin), cattle (Rademacher) and dogs (Delafond).

Symptoms. The disease usually begins by a minute papule on the head or neck and it rarely extends upon the body. The papules multiply and form vesicles, which rupture, exuding a liquid that condenses into a crust. These crusts mat the hair together in tufts, and through additions to the crusts and the continuous scratching induced by the itching, the hair is shed leaving bald, raw or encrusted areas. The exudate further invades the skin and subcutaneous connective tissue, with thickening, rigidity, swelling and blocking of the natural orifices. As the face especially suffers the eyelids are encrusted and inverted over the sunken eyes, the lips are thick, crusted and inelastic, the nostrils are blocked, and the respiration sniffling. The animal becomes dirty and haggard, eats little, wastes day by day, yet may live from three to six months. Thus young kittens suffer most acutely and die earliest, and especially in localities where a number of cats are affected.

Diagnosis depends on the limited area affected—the head—the attendant itching, the fact that a number of cats suffer in the same place, and above all on the discovery of the sarcoptes, which may be found beneath the scabs. If difficulty is met with, the exposed skin may be scraped and the scrapings steeped for two hours in caustic potash solution (1:10) or the scabs may be tied on the human arm.

Treatment is difficult owing to the risk of poisoning the cat. On the whole the sulphur ointment (sulphur 2, carbonate of potash 1 and vaseline 8) is the best and safest application. It is of the utmost importance to institute treatment in the early stage before the strength and vigor of the patient have been under-

mined. Styrax ointment has succeeded in the hands of Friedberger and Fröhner. Bell succeeded with solution of zinc chloride (4:500).

SARCOPTIC SCABIES. ACARIASIS IN FERRETS.

S. Scabei v. hydrochœri: Attacks head and feet; tufted hair, exudate, crusts, chaps, sores, claws overgrown, intense itching, walks on foot-pad. *Treatment:* Sulphur cream or ointment.

This is due to **Sarcoptes Scabei var. Hydrochœri** and not to the sarcoptes minor as in rabbits. The ovigerous female is .36 mm. long and the male .22 mm. A few attempts to transmit it to man and dog have failed. The polecat is suspected to be the source of the infection. It must not be confounded with the Listrophorus Mustelæ which is a harmless commensal on both ferret and polecat.

It attacks chiefly the head and feet, but may spread to any part of the body. At first there is a moist condition of the skin, with excess of the normal scent, later there are crusts which mat the hair in tufts, then depilation, and the formation of chaps and sores. The head may be covered by a continuous crust broken up into small masses, also the digits and interdigital spaces, and the claws grow out to an extreme length, becoming straight or even bending upward. Intense itching is shown from the beginning, the ferret scratching and biting itself with great energy. The concentration of the eruption on the lower surface at the root of the claws, causes the animal to walk slowly and on the back part of the foot.

Treatment, as in the sarcoptes minor of the cat, is necessarily confined to the use of the simplest non-poisonous acaricides. A liberal use of sulphur in combination with glycerine, vaseline or lard appears to be the best and safest resort. If the crusts are thick and hard, carbonate of potash may be added, or soap may be used as the excipient.

SARCOPTIC SCABIES OF THE LEGS IN BIRDS.

Sarcoptes Mutans: Rounded papillary processes on back of female; absence of suckers at posterior border of male. *Symptoms:* Disease of scaly part of legs and feet; exudation under scales forming friable mass, with cavities for acari; vascular surface, red, tender; ova rare; itching worst at night, pecking leg, lameness, weakness, arthritis, gangrene, debility, emaciation, ceases to lay; death in 6 to 12 months. *Treatment:* Segregate diseased, clean, disinfect house, soften scales in tepid water, then smear with sulphur ointment. Naphthalin, lysol, etc., may be used.

This affection is found not only in chickens, but also in turkeys, pheasants, partridges, bullfinches, goldfinches, paroquets, etc. It is probably common to all granivorous birds and palmipedes.

The cause of the affection is **Sarcoptes Mutans, Changing Sarcoptes,** which is characterized by the presence of numerous rounded papillary processes on the whole back of the female, and the absence of the usual copulatory suckers near the posterior border of the ventral aspect of the male. The *female* is .40 to .45 mm., and the male 20 mm. in length.

Symptoms. These sarcoptes appear to live exclusively on the legs and especially under the scales in front of these members. They give rise to exudation with accumulation of a great amount of a white powdery material which elevates the scales, in irregular masses and processes, greatly thickening and distorting the leg. When the scales are picked or broken off by accident, the crust on the inner side is friable, being hollowed out into a system of cavities and canals in which the acari have burrowed, and any exposed vascular surface is red, tender, and ready to bleed. In the deepest layer in the larger excavations are found the motionless ovigerous females, while the larvæ, nympha and males are generally distributed throughout the crust and on the skin. Ova are rare as the parasite is ovoviviparous. Itching is a marked feature, especially at night, and leads to pawing and pecking at the affected limb. In this way as well as by pressure of the super-incumbent crusts, inflammation is aggravated and lameness, inability to stand for long, arthritis and even gangrene of the toes are brought about.

The disease runs a slow course gradually undermining the health, lowering condition, and interrupting laying, until the bird dies in marasmus in from six to twelve months. When complicated by *lophophytosis*, *diphtheria*, *coccidiosis*, *tubercle* or other disorder a fatal result is hastened.

Treatment. The disease spreads slowly from fowl to fowl; one infested sometimes remaining in a flock for a length of time without infesting others. The larger the number affected however, and the more advanced the disease, the greater the danger of infection. All diseased birds should therefore be removed from the flock, and the poultry house, but especially the nests and roosts, deluged with a boiling solution of caustic potash, followed by saturation with a 5 per cent. solution of carbolic acid.

For the affected birds the limbs should be dipped in a bath of tepid water until the scabs are softened, then these are carefully removed, and the whole member thickly covered with a sulphur ointment (sulphur 2 drs., carbonate of potash 1 dr., lard 1 oz.). Ointments of phenol, napthalin, creosote, lysol or creolin may be substituted. For some time thereafter the limb is sensitive and should be protected by vaseline, oil, or glycerine.

SARCOPTIC SCABIES OF THE BODY OF CHICKEN OR PIGEON. DEPLUMING SCABIES.

S. Lævis: No mammiform elevations on dorsum of female; copulatory suckers in male. Varities: *S. L. v. Gallinæ*, and *S. L. v. Columbæ*, the latter the smaller. *Symptoms:* pecks out feathers from rump, thighs, back, belly, breast and neck; excess of epidermic scales, with acari, quills broken at skin, debility, emaciation, laying falls off, flesh lacks flavor. Spreads rapidly, especially through *treading*. Most active in spring and summer. *Treatment:* Dry dust baths with phenol, sulphur, calcium sulphide, insect powder, stavesacre, sulphur ointment, carbon sulphide. Disinfect nests, roosts, houses, runs, etc.

This acariasis differs from that last described in attacking the feathered portions of the body, and causing loss of feathers.

It is caused by **Sarcoptes Lævis** which is somewhat smaller than the *Sarcoptes mutans* and further differs in the absence of the mammiform projections on the back of the female, and in the presence of two copulatory suckers on the posterior part of the

ventral aspect in the male. Two varieties differing slightly in size are found on hen and pigeon respectively.

Sarcoptes Lævis var. Gallinæ. Ovigerous female is .31 to .35 mm. and the male .17 to .18 mm. long. Discovered in 1886 on a chicken (Railliet).

Sarcoptes Lævis var. Columbæ. Ovigerous female .27 to .31 mm. and the male .14 to .17 mm. long. Discovered in 1855 on a messenger pigeon (Railliet and Cadiot).

Symptoms. The bird is noticed to peck out its feathers more especially around the rump, then the thighs, back, belly, breast and neck, and it is not uncommon to find one performing this service for another. Examination of the parts shows an excessive production of epidermic scales, especially around the points of insertion of the quills, and in this debris a number of the actively moving acari. The quills are often found to be broken off at the level of the skin, and the remaining part crumbling into powder. Masses of powder with acari are also found at the junction of the quill and shaft. The congestion and irritation of the skin is moderate, the normal smoothness, thinness and suppleness being often retained, but debility and emaciation set in, the yield of eggs is lessened and the flesh loses in flavor.

The disease spreads from bird to bird with great rapidity, largely, it would appear, through the cock *in treading*, and may attack a whole flock in a few days. Neumann has observed that it is much more marked in spring and summer and subsides in great measure in autumn and winter.

Treatment. Dry dust baths in covered boxes, and having a liberal admixture of sulphur, phenol, insect powder or powdered stavesacre will often suffice. If not, the parts may be rubbed with sulphur ointment, or the exposed skin sprayed with bisulphide of carbon. Disinfection of nests and roosts is desirable.

DEMODECIC SCABIES.

Demodex, worm-like, in hair follicles and sebaceous glands. **Demodex Folliculorum v. hominis**, in human nose, etc., causing *comedon*. **Demodex Folliculorum v. Canis**, in eyelids, toes, elbows, hocks, or body of dog. Redness, circular depilation, papules, scurf, skin thickened, puckered, bald, large papules, pustules, bluish red or pink with whitish centre.

Cheesy or pus-like sebum pressed out and cleared by ether shows acari. *Susceptibility*: Youth, short hairs, unexplained personal proclivity. May pass to man. **D. Folliculorum v. Felis.** *Treatment*: Dissolve sebum by carbon bisulphide, benzine, phenol, lysol, potassium sulphide, Peru balsam. Sulphur internally. **D. Folliculorum v. Suis**: Attacks snout, neck, breast, axilla, abdomen, groin, etc.; 1000 in follicle, abscess, millet-seed to hazelnut; become confluent. *Treatment* as in dog. **D. Folliculorum v. Capræ**: On sides of body and flanks; nodules, pea, hazelnut filled with sebum and acari. **D. Folliculorum v. Ovis** in Meibomian glands of sheep, causing conjunctivitis. **D. Folliculorum v. Bovis**: Short abdomen, long rostrum and cephalo-thorax. Found in muzzle and hides of cattle, resulting abscesses; low value of skin. **D. Folliculorum v. Equi**: Found in Meibomian glands and upper lip of horse. **D. Folliculorum v. Cuniculi.**

This form of acariasis is characterised: 1st, by the vermiform outline of the parasite, the abdomen of which is prolonged in the form of a worm (demodex wormlike); and 2nd, by the habitat of the parasite in the hair follicles and sebaceous glands of the skin. The specific name of *Demodex Folliculorum* has been given to the mite while the variety found on any special animal is further named after its host.

The **Demodex Folliculorum** has a broad short rostrum with cheliceræ, jaws and tongue; a cephalo-thorax, one-third longer than broad, and furnished with four rudimentary limbs, on each side, on the flat ventral aspect, and close to the border; and lastly the conical worm-like abdomen, about three times the length of the cephalo-thorax and finely striated across. They are oviparous, the egg being elipsoid, and the young pass through the same stages of hexapod larva; octopod, non-sexual nympha; sexually mature male and female; and ovigerous female; that are seen in other acarina.

Demodex Folliculorum var. Hominis. This inhabits the sebaceous glands of the human face, especially the nose, and when twelve or more exist in one cavity they give rise to the acne-like swelling known as *Comedon*. The female measures .38 mm. and the male .30 mm. in length.

Demodex Folliculorum var. Canis. The female measures .25 to .30 mm. long; the male .22 to .25 mm.

It lives in the sebaceous glands, of the eyelids, toes, elbows and hocks, and later by extension on any part of the body. At

first there are redness, depilation, small papules and a slight scurfiness of the affected spots. Later the redness becomes intense, the skin thickened, scabby, corrugated and bald, with more projecting papules and pustules. The papules may show a dark-bluish red color, or they may be pink with a whitish center. In some instances the follicle is open and discharges a pus-like fluid in which numerous acari can be found. In some instances pressure forces out a cylindroid mass of sebum which being dissolved in alcohol or ether shows abundance of the acari. As in other parasitic affections causing evulsion of the hair (ringworm) there is a tendency to form circular bald spots (*circinate form*), on which, in this case, the papillary elevations appear. In some instances there is little congestion or eruption and for a time the affection is chiefly marked by a great shedding of hairs and dandruff (*squamous or scaly form*). Itching is usually moderate.

Diagnosis is to be made from *red mange* with difficulty, but the latter affects first the inside of the elbows and thighs, the breast and abdomen, and furnishes no acari on examination, while this scabies affects first the paws and head and the matter squeezed from the acne-like elevations furnishes the demodex in great abundance. It must be borne in mind that the presence of the demodex often coincides with other parasitisms and non-parasitic diseases of the skin, and even, as Laulanie has shown, with cutaneous tuberculosis.

Susceptibility. Youth especially predisposes, and short hairs appear to (Cornevin). We cannot, however, fully explain why certain animals are especially receptive and others resistant. Haubner and Cornevin respectively transmitted the disease from dog to dog, only to find a spontaneous recovery in eight days. Many other attempts have failed from the first. The fact of living together rarely transmits it (Weiss, Friedberger, Siedamgrotzky, Csokor).

Zurn claims to have seen a number of persons infested, who handled demodecic dogs, while a number of others have inoculated man from the dog without effect (Martensucci, Friedberger, Cornevin).

Demodex Folliculorum var. Felis. Cat. One fourth smaller than that of the dog.

Treatment. Demodecic Scabies is difficult to deal with because the parasite lives so deeply in the hair follicles and gland ducts where ordinary external dressings fail to reach it. The great desideratum is to get something that will dissolve the cerumen and make its way to the bottom of the follicular recesses. To meet this, carbon bisulphide 10 parts, vaseline 30 parts (Megnin), or the bisulphide and sweet oil in the same proportions may be rubbed into the affected parts daily. Zurn recommends benzine 1 part, lard 4 parts; and Hofer carbolic acid 1 part, lard 30 parts. By replacing the lard by olive oil a more diffluent and penetrating agent is obtained. Creolin or lysol 1 part, olive oil 14 parts may be used. Brusasco gave a bath of potassium sulphide ½ to water 100 and followed by unguentum cantharidis (1:6). Benzine, phenol, or creosote liniment might be substituted for the Spanish fly. Megnin employed sulphur baths daily for a month keeping the dog in the bath for 15 minutes each time and kneading or shampooing the skin throughout. In the second month he gave the bath every second or third day. He further succeeded with calcium sulphide made by boiling 100 grammes sulphur with 200 grammes of quicklime in a liter of water, then setting aside, and decanting and using the clear solution. This he rubbed into the skin with a sponge daily until successful. Fleming advises that sulphur should be given internally. Around the eyes, balsam of Peru 1 part, alcohol 4 parts is a bland and effective application. It is rubbed in daily after the contents of the follicles have been squeezed out. Cadeac scarifies the skin (acne) and applies tincture of iodine. Essence of juniper with friction to dressings cured (Unterberger).

Demodex Folliculorum var. Suis. (D. Phylloides). The female is .24 to .26 mm. long and the male .22 mm. It invades the more delicate portions of the skin, snout, neck, breast, abdomen, inner sides of thighs and forearms, and usually respects the tougher dorsal aspect. The parasites seem to multiply rapidly, as many as 1000 having been found in a single follicle. They cause suppurating cavities (pustules) from a millet seed to a hazel nut in size, the smaller sacs bursting into each other to form one large one. Nothing is recorded as to treatment which would naturally be along the same lines as in the dog.

Demodex Folliculorum var. Capræ. The female is .23 to

.25 mm. long and the male .22 to .23. They have been found on the sides of the body and flanks, giving rise to hard swellings, varying in size from a pea to a hazelnut, and yielding, when squeezed, a large amount of ceruminous debris, made up largely of the demodex.

Demodex Folliculorum var. Ovis. This was found by Oschatz in the Meibomian glands of the sheep, causing conjunctivitis and an appearance of stye. It differed from that of man in having a longer rostrum and cephalo-thorax.

Demodex Folliculorum var. Bovis. The length is 20 mm. The abdomen is short, the rostrum and cephalo-thorax forming two-fifths of the total length. This acarus was found in the muzzle of cattle; also in the hides of Illinois and Minnesota cattle (Faxon). The hides when tanned still showed the cavities extending through their thickness. Grimm found a poor unthrifty heifer with pea-like nodules all over the body, but especially on the shoulders. When squeezed these yielded a thick viscid pus containing enormous numbers of the demodex. The head and limbs were unaffected. The other animals in the herd were healthy and thrifty. All had an abundant ration.

Demodex Folliculorum var. Equi. This was found by Erasmus Wilson in the Meibomian glands of the horse, causing inflammation of the tarsi as in the parallel case in the sheep. Gros also found the parasite in the upper lip of the horse.

Demodex Folliculorum var. Cuniculi. Rabbit, in sebaceous follicles (Pfeiffer).

LINGUATULA TÆNIOIDES.

Degraded archnida, with dwarfed legs like two pairs of hooks. Body vermiform, broadening to head, annulated, with denticulated rings; larva and mature form in different organs and species. *Mature Linguatula Tæniioides:* Elongated, worm-like, lanceolate toward head, tail long, thin, flattened, venter flat, dorsum rounded; 90 rings; sharp, curved, retractile oral hooks. Hosts: Nose and air chambers of head; dog, fox, wolf, horse, goat, sheep, ox. *Ovulation:* 500,000 eggs, sneezed out, are taken in with food and water by herbivora. Embryo hatched in stomach, with protractile stylet (*rostrum*) bores to lymph gland, becomes pupa, in 8 weeks nympha, and finally a non-sexual larva. *Larva* (*Linguatula Denticulatum*) in 6 or 7 months, migrates to the peritoneum, pleura, lungs or bronchia and nose,

or host being eaten by carnivorus animal, they develop to maturity in its nose. Common in Paris in butchers' and shepherd dogs, and in Roumanian oxen. *Symptoms of nasal Linguatula:* Sneezing, snuffling, rubbing nose, cough, dyspnœa, choking, morose, snappish, epilepsy, delirium, epistaxis, parasite in discharge. *Treatment:* Inject tepid water or benzine in oil. *Symtoms of larva:* Unnoticed, or loss of condition. *Prevention:* Deny raw offal to dogs; treat sneezing dogs; exclude dogs from sheep-pastures. Other pentastomata.

The genus **linguatula** (tongue-like) is a degraded form of *Arachnida*, in which the legs have become rudimentary, being represented by two pairs of hooks to the right and left of the mouth; the body is vermiform, broad toward the head and narrow toward the tail, and annulated, each ring in the mature form being dentated, the sharp, pointed teeth turned backward. The respiration is cutaneous. The larva and mature specimens occupy different organs, usually different species of vertebrate hosts.

Mature Linguatula Tænioides. This is a whitish, elongated worm-like parasite, lanceolate in its anterior third, and prolonged into a long attenuated tail, flattened from above downward, ventral aspect plane, dorsal aspect well rounded, formed of about 90 rings giving a notched appearance to the lateral margins and a moniliform aspect to the tail, mouth round or partly quadrangular, oral hooks sharp, curved backward, in two segments and retractile. The *female* is 2 to 2⅓ inches long by 8 to 10 mm. broad in its anterior part (2 mm. in tail). The *male* is 18 to 20 mm. long, by 3 mm. broad in the anterior part (0.45 mm. in the tail.)

Hosts of Mature Linguatula Tænioides. This inhabits the nasal chambers, turbinated bones and (exceptionally) frontal sinuses of carnivora especially :—*dog* (Weisberg, Chabert, etc.), *fox* (Monies), *wolf* (Bremser, Colin, Miram), *mule* (Greve), *horse* (Chabert, Leblanc, Rose, Csokor), *goat* (Brückmüller), *sheep* (Rind), *ox* (Babes), *hare* (Gurlt).

Ovulation. The eggs are ovoid, produced in great numbers, (500,000, Leuckart), and contain partially developed embryos when laid. Expelled by the frequent sneezing of the host, they dry, adherent to the vegetation, and are taken in by herbivora, omnivora (cats and other carnivora), with their food and water. They can resist for weeks the influence of atmospheric changes at this stage.

Embryo. In the stomach the shell is digested and the embryo set free. This has an ovoid body flattened beneath, furnished with two pairs of very rudimentary legs, and on its anterior a stylet and two hooklets, by the aid of which it bores into the tissues. Its favorite destinations are the mesenteric lymph glands, liver, lungs, pancreas or other solid organ. It is destitute of sexual organs, and measures 130 μ long, by 60 μ broad. In its new home it undergoes a series of moultings and passes into the form of agamous larva. In the gland, etc., it quickly loses legs, perforating rostrum, segments, hooks and hairs, becoming a motionless ovoid pupa, 250 μ by 180 μ. In about 8 weeks each is seen to contain a nympha, and this is developed into a larva, which largely represents the mature linguatula, except for the absence of generative organs.

Larva. This is 4 to 8 mm. long, by 1 to 2 mm. broad anteriorly. The larva has a fully developed digestive system, two pairs of lateral hooklets by the sides of the mouth, and distinct rings dentated sharply on their posterior borders. This form has been known as **linguatula** (or **pentastoma**) **denticulatum.** Toward the sixth or seventh month, when fully developed as larvæ, these migrate from their evolution-habitat and pass into other organs (lungs, bronchia) or fall into serous cavities (peritoneum, pleura). They do not reach sexual maturity outside of the air passages so that large numbers perish at this stage of their existence. Sometimes, however, the host is devoured by a carnivorous animal and the larvæ reach maturity in its nasal cavities ; in other cases the larva reaches the bronchia of its first host and makes its way to the nasal chambers to be matured in the same animal. In six or seven weeks they reach sexual maturity, and reproduce their kind.

Frequency. In some localities linguatula is common. Colin found it in ten per cent. of the dogs opened at the Alfort Veterinary College, Paris, most in butchers', shepherds' and street dogs, and fewest in house dogs. It may be equally common in other localities where it has been recognized. Babes found it in the nose of all Roumanian oxen examined (35 head).

Nasal Symptoms from Mature Linguatula. These have been noted by Colin in experimental cases, and by others in casual ones, especially in dogs. When first attacked the pricking of

the Schneiderian membrane by the buccal hooks gives rise to a little irritation and sneezing, but this decreases as the mucosa becomes more tolerant. This early symptom usually passes unobserved. If the parasites are few in number, no more marked phenomena may appear, and the disease passes unsuspected. When the linguatula are numerous, on the other hand, they interfere more or less with the passage of air, causing more or less snuffling, and frequent and violent paroxysms of sneezing. The dog rubs his nose with his paws as if to remove some offensive agent, tears flow from the eyes and saliva from the mouth, and there may be violent coughing or even dyspnœa. Dick records a case of sudden death of a dog from asphyxia, with one linguatula in the larynx, one in the trachea and one in the left bronchus. They sometimes give rise to reflex nervous troubles such as epilepsy or delirium (rabiform symptoms). In other cases the dog is morose, snappish and dangerous. In one instance the parasite was found to have entered the middle ear, so that pain or itching of that organ, deafness or vertigo might have been looked for. Landon noted epistasis in an affected man, which promptly disappeared as soon as the parasites had been evacuated. A conclusive symptom is the presence of ova in the discharged nasal mucus, and better still of a mature linguatula. By washing out the nasal chambers with tepid water this evidence may be increased. A single invasion in the nose may last for two years (Colin).

Treatment. This consists of careful syringing out of the nasal chambers with tepid water. A more effective proceeding is to fill each nasal chamber in succession with a mixture of benzine in olive oil (5:100). Enough of this will remain adherent to the mucosa to destroy the parasite.

Symptoms Caused by the Larvæ. As a rule these pass entirely unnoticed. If very numerous, troubles may follow varying with the organ invaded: emaciation from infested mesenteric glands; icterus or intestinal disorder from the liver; cough from the lungs. Usually a slight lack of condition, only, is seen in the affected animals, but in no case is there any hope of a certain diagnosis during life.

Prevention. This must aim at interrupting the normal cycle of development of the parasite. In localities where this exists dogs should be denied access to all raw offal of sheep or other her-

bivora. The waste product of abattoirs must be sterilized by heat, and the heads and carcases of dead sheep, etc., must be treated in the same way.

Dogs affected with paroxysmal, dry sneezing must be treated, and, as far as possible, all dogs should be excluded from sheep pastures.

OTHER LINGUATULÆ. Railliet records the following instances of infestment by other linguatulæ : *Linguatula Recurvata* in the frontal sinus and trachea of a jaguar in Brazil ; *Linguatula Subtriquetra* in the throat of an Alligator ; *Pentastomum Moniliforme* in the lungs of a striped python and in the liver and other viscera of dogs, lions and panther ; *Pentastomum Proboscideum* and *P. Subcylindricum* in the lungs of American reptiles and mammals ; **Pentastomum Constrictum** in the lungs, etc., of negroes and giraffe in Egypt, and in soldiers, causing fatal pneumonia and peritonitis. It is, therefore, not improbable that opportunity only is lacking to make these parasites of domestic animals.

SCORPIONS.

Scorpions look dangerous by reason of their formidable crab-like, pincer claws, but these are comparatively harmless. The real danger lies in the venomous sting in the end of the tail but even this is not serious except in the case of some large tropical species (nine or ten inches long) and when used on small animals. On the larger it may cause a local inflammation but no more. In Europe Maupertius found that dogs and chickens suffered only temporary inconvenience from the sting, while in Redi's hands it proved occasionally fatal to pigeons. Jousset dealing with the tropical species found that the venom caused agglutination of the red blood globules, blocking of the capillaries, and gangrene. The tail strikes upward and the animal may be safely handled by seizing the last caudal segment.

ANNELIDÆ (anellus, a ring). Formed of rings.

VERMES. HELMINTHES WORMS.

CESTODES (kestos girdle). PLATHELMINTHS. TAPEWORMS. Flat, segmented worms; no true digestive organs; hermaphrodite.

TÆNIA (TAPEWORMS) PROPER.

CYSTOTÆNIÆ. Caudal vesicle in cystic form, is a continuous development from the head.

In Larval or Cystic Form.

Cysticercus. Each ovum develops one cyst with one head.
Coenurus. Each ovum develops one cyst with many (100 to 200) heads.
Echinococcus. Each ovum develops one cyst, which forms daughter and granddaughter cysts with or without heads. Multilocular.

TÆNIÆ WITH CYSTICERCUS LARVÆ.

Cysticercus Larva.	*Habitat.*	*Mature Tænia.*
C. Tenuicollis (tenuis delicate, colle neck)	Peritoneum, pleura, liver. Ox, sheep, goat, pig. Connective tissue cat, man.	**T. Marginata.** Habitat. Small intestine. Dog.
C. Mediocanellata (medius middle canal).	Connective tissue of muscles. Calf.	**T. Mediocanellata (Saginata).** Habitat. Small intestine. Man.
C. Cellulosa.	Connective tissue of muscles. Pig, dog, man.	**T. Solium.** Habitat. Small intestine. Man.
C. Pisiformis (Serrata)	Viscera. Rabbit, bird.	**T. Serrata.** Habitat. Small intestine. Man, dog.
C. Fasciolaris	Liver. Mouse, rat, rodents.	**T. Crassicollis.** Habitat. Small intestine. Cat.

C. Fistularis.	Peritoneum. Horse.	——— ?
C. Krabbei.	Connective tissue. Reindeer.	**T. Krabbei.** Habitat. Small intestine. Dog.
C. Bailleti. (plerocercoides)	Peritoneum, pleura. Cat, dog.	——— ?
C. Bothrioplitis.	*Helix Maculosa.*	*T. Bothrioplitis.* *Habitat. Intestine. Hen.*

TÆNIÆ WITH CŒNURUS LARVÆ.

Cœnurus Larva	*Habitat.*	*Mature Tænia.*
C. Cerebralis.	Brain, spinal cord. Sheep, goat, ox (horse?).	**T. Cœnurus.** Habitat. Small intestine. Dog, wolf, fox.
C. Serialis.	Connective tissue. Rabbit, hare.	**T. Serialis.** Habitat. Small intestine. Dog, wolf, fox.

TÆNIA WITH ECHINOCOCCUS LARVA.

Echinococcus *Larva.*	*Habitat.*	*Mature Tænia.*
E. Veterinorum (polymorphus, hominis).	Liver, spleen, lungs, etc. Ox, sheep, goat, pig, horse, man. Peritoneum. Dog.	**T. Echinococcus.** Habitat. Small intestine. Dog, wolf, fox.

Cystoidotænia. Caudal cyst in larva is small, void of liquid and connected with the head by a special segment (blastogene).

Larva	*Habitat*	*Mature Tænia.*
Cryptocystis Trichodectes (cysticercus canina).	Abdomen of Trichodectes Canis and Pulex Serraticeps.	**T. (Cucumerina) canina.** Dipylidium canina. Habitat. Small intestine. Dog.

ANOPLOCEPHALINÆ. ANOPLOTÆNIÆ. UNARMED TÆNIÆ.

——— ?	**T. Plicata.** Habitat. Small intestine. Horse.

——— ? **T. Mammilana.**
Habitat. Small intestine.
Horse.

——— ? **T. Perfoliata.**
Habitat. Small intestine.
Horse.

TÆNIA WITH CYSTIC OR LARVAL FORM UNKNOWN OR UNCERTAIN.

Mature Tænia	*Habitat.*	
T. Litterata (*Pseudo-Cucumerina*).		
	Small Intestine.	Dog.
T. Expansa.	Small Intestine.	Sheep, Ox.
T. Fimbriata.	Small Intestine. Gall Ducts.	Sheep, Deer.
T. Denticulata.	Small Intestine.	Ox.
T. Alba.	Small Intestine.	Sheep,
T. Benedeni.	Small Intestine.	Sheep.
T. Aculeata.	Small Intestine.	Sheep.
T. Ovilla.	Small Intestine.	Sheep.
T. Giardi.	Small Intestine.	Sheep.
T. Vogti.	Small Intestine,	Sheep.
T. Centripunctata	Small Intestine.	Sheep.
T. Globipunctata	Small Intestine.	Sheep.
T. Ovipunctata.	Small Intestine.	Sheep.
T. Capræ.	Ileum.	Goat.
T. Elliptica.	Small Intestine.	Cat, Man.
T. Pseudo-Elliptica.	Small Intestine.	Cat, Man.
T. Pectinata. (5 species Riehm)	Intestine.	Rabbit.
T. Lanceolata.	Intestine.	Goose, Duck.
T. Sinuosa.	Intestine.	Goose, Duck.
T. Trilineata.	Intestine.	Duck.
T. Coronula.	Intestine.	Duck.
T. Gracilis.	Intestine.	Duck.
T. Fasciata.	Intestine.	Goose.
T. Setigera.	Intestine.	Goose, Swan.
T. Malleus. (Fasciolaris)	Intestine.	Goose, Duck, Hen.
T. Infundibuliformis. (Larva in earth worm).		
	Intestine.	Hen.
T. Cesticellus.	Intestine.	Goose, Duck, Hen.
T. Proglottina. (Larva in snails).	Duodenum.	Hen.
T. Megalops.	Intestine.	Duck.
T. Anatina.	Intestine.	Duck.
T. Conica.	Intestine.	Duck.
T. Imbutiformis.	Intestine.	Duck.

T. Cuneata. (Larva in earth worm)	Intestine.	Hen.
T. Tetragona.	Intestine.	Hen.
T. Echinobothrida.	Intestine.	Hen.
T. Crassula.	Intestine.	Pigeon.
T. Exilis.	Intestine.	Hen.
T. Cantaniana.	Intestine.	Turkey, Peafowl, Pheasant.
T. Cesticillus v. Phasianorum.	Intestine.	Pheasant.
T. Friedbergeri,	Intestine.	Pheasant.
T. Æquabilis.	Intestine.	Swan.

BOTHRIOCEPHALIDÆ. FLATHEADED TAPE WORMS.

Bothriocephalus (bothros pit, cephale head). Tapeworms without rostrum or hooklets, head flat, two lateral elongated suctorial pits; mature may develop from ovum in one host.

Mature Parasite.	*Habitat.*	
Bothriocephalus (Dibothriocephalus) Latus (latus broad)	Intestine.	Man, dog.
B. (Dibothriocephalus) Cordatus (cord shaped).	Intestine.	Man, dog.
B. (Dibothriocephalus) Felis	Intestine.	Cat, ounce, leopard, etc.
B. (Dibothriocephalus) Fuscus	Intestine.	Dog.
B. (Dibothriocephalus) Reticulatus.	Intestine.	Dog.
B. (Dibothriocephalus) Dubius (probably reticulatus).	Intestine.	Dog.
B. (Dibothriocephalus) Longicollis.	Intestine.	Hen.

TREMATODES (trematodes pierced). FLUKES.

Soft, nude, non-articulated bodies, often flat, one or more suckers, mouth and digestive canal, no anus, hermaphrodite, (in the blood, flukes with sexes in separate individuals). Alternate generations, larvæ mostly in molluscs.

Parasite	*Habitat.*	
Distoma Texicanum (Giganteum) (dis twice, stoma opening).	Tissue of liver, lung, etc.	Ox.
D. Hepaticum.	Gall ducts (intestine).	Sheep, ox, goat, pig, horse, man, etc.
D. Lanceolatum.	Gall ducts (intestine).	Sheep, ox, goat, pig, ass, rabbit, hare, cat, man.

D. (Dicrocœlium) Pancreaticum: Pancreatic duct.	Ox, sheep, buffalo, E. & S. Asia.
D. Campanulatum (Truncatum)	Cysts on bile ducts. Dog, Bolonga; cat, fox, seal.
D. Sinense.	Liver. Cat, China, Japan, N. America, India, Holland, Italy.
D. Conjunctum.	Fox, N. America; Seal, Greenland.
D. Caviæ	Bile ducts. Guinea-pig.
D. Pellucidum.	Gullet. Hen.
D. Lineare.	Large intestine. Hen.
D. Dilatatum.	Cæcum and rectum. Hen.
D. Armatum.	Cæcum and rectum. Hen.
D. Comutatum (*Mesogonimus*).	Cæcum and rectum. Hen, pigeon.
D. Ovatum.	Oviducts. Geese, ducks; eggs, hen.
D. Echinatum (larva in snails).	Intestine. Duck, goose, dog.
D. Oxycephalum (v. of last).	Intestine. Duck, goose (hen).
D. Cuneatum.	Oviduct. Pea hen.
Paragonimus (D.) Westermannii Distoma Pulmonale.	Lungs. Man, dog, pig, cat, tiger.
Amphistoma Conicum (amphi both sides) *A. Cervi.*	First stomach. Ox, sheep, goat, ruminants.
A. Collinsi.	Stomach. Horse.
A. Collinsi v. Stanleyi.	Stomach. Horse.
A. Truncatum.	Gall ducts. Cat.
A. (Gastrothylax) Crumeniferum.	Ox. Zebu.
A. Tuberculatum.	Intestine. Ox. India.
A. Hawkesii.	Intestine. Elephant. India.
A. Explanatum.	Bile ducts. Zebu.
Holostomum (*anatis*) Erraticum.	Intestine. Duck.
Gastrothylax Gregarius.	Stomach. Indian buffalo.
Homalogaster Poirieri.	L. intestine. Cattle, (Zebu?).
Hemistoma Alatum.	Intestine. Dog, fox.
H. Erraticum.	Duck, swan.
Monostoma Mutabile (monos one).	Suborbital cavities, nose, trachea, bronchi. Goose.
M. Attenuatum.	Goose.
M. Triseriale.	Cæcum. Goose.
M. Verrucosum.	Cæcum. Duck.

M. Caryophyllinum. Duck.
Gastrodiscus Sonsini (Ægyptiacus). Small intestine. Horse, mule. Egypt. Senegal, Guadaloup.
Agamodistomum. Muscles. Swine. United States.
Bilharzia (Schistosoma) Hæmatobia. Blood, man (ox).
B. Crassa (Schist. bovis) Blood. Ox, buffalo, sheep. Asia, Africa.
Cephalogonimus ovatum. Intestine. Fowl.
Mesogonimus Dimorphus. Intestine. Fowl. Turkey.
M. Pellucidus. Gullet. Fowl.

NEMATHELMINTHS (nema thread, round; helminthos, worm.)

Cylindroid; sexes in separate individuals.

ACANTHOCEPHALI (acanthos thorn, hook; cephale head.)

Protractile proboscis with recurved hooks; no digestive canal.

Genus: *Echinorhynchus* (echinos spined, rynchus proboscis).
E. Gigas (gigas giant). Small intestine. Pig.
E. Polymorphus. Intestine. Duck, goose, swan.
E. Filicollis. Duck.
E. Sphaerocephalus. Duck.
E. Cuniculus. Intestine. Rabbit.

GENERA AND SPECIES OF ROUND WORMS.

Genus: TRICHOSOMA (trix hair, soma body). Caudal part of body hairlike. Whip-worm.
T. Papillosum. Small intestine. Sheep.
T. Plica. Urinary bladder. Dog, fox, wolf.
T. Aerophilum. Trachea. Cat, fox, martin, etc.
T. Felis. Urinary bladder. Cat.
T. Brevicolle (breve short, neck). Cæcum. Duck, goose.
T. Retusum. Intestine. Fowl.
T. Tenuissimum. Intestine. Pigeon.
T. Contortum (twisted). Submucosa, gullet. Ducks. Intestine. Birds.
T. Longicolle. Intestine. Hen, partridge.
T. Columbæ (*Tenuissimum*). Intestine. Pigeon.
T. Lineare. Intestine. Cat.
T. Annulatum. Intestine. Chicken.
T. Collare. Intestine. Chicken.

Genus: TRICOCEPHALUS (trix and cephale head): Cephalic part of body hairlike. Whip-worm.

T. Affinis (Allied). Cæcum. Ruminants.
T. Crenatus (crenate) (Dispar?). Large intestine. Pig. (Man?)
T. Depressiusculus. Cæcum. Dog, fox.
T. Unguiculatus. Cæcum. Hare, rabbit.

Genus: FILARIA (filum hair, thread).
F. Papillosa (Equina). Peritoneum, aqueous humor, Fallopian tube, etc. Horse.
F. Cervina. Peritoneum, aqueous humor. Ox.
T. Palpebrarum (**Lachrymalis**). Conjunctival sac. Horse.
F. Trispinulosa. Larva, aqueous humor. Dog.
F. Evansi. Blood. Camel.
F. Sanguinis. Blood. Dog.
F. Immitis. Heart. Blood. Dog.
F. Osleri. Tubercles on bronchia. Dog.
F. Hepatica. Mucosa of Gall ducts. Dog.
F. Irritans. Skin and subcutem. Horse.
F. Haemorrhagica (**Multipapillosa**). Skin and subcutem. Horse, mule.
F. Calva. Peritracheal conn. tissue. Pigeon.
F. Cygni. Intestine, abdomen. Swan.
F. Anatis. Around heart. Duck.
F. Mansoni. Aqueous humor. Hen, etc. China.
F. Medinensis (**Guinea worm**). Subcutem. Man, dog, horse. ox.
F. Recondita (**Sanguinis Canis**). Embryos in blood. Dog.
F. Sanguinis Equi. Blood. Horse. Egypt, Pisa, Kazan.

Genus: SCLEROSTOMA (scleros hard, stoma mouth).
S. Equinum (*Strongylus Armatus*). *Mature* in large intestines: *immature* in cysts in mucosa, arteries of gastro-intestinal and other abdominal organs, and of other parts, causing colic, aneurism, and embolisms. Solipeds.
S. Tetracanthum (*Strongylus*). Large intestines; *immature* cysts in mucosa. Solipeds.
S. Hypostomum. Large intestine. Sheep, goat.
S. Pinguicola. Submucous Cysts. Swine.
Genus: SYNGAMUS (syn with, gamos marriage). Male and female always united.
S. Trachealis. Trachea. Birds. Chicken, Turkey, Pheasant, Peafowl, Partridge, Sparrow and many wild birds.
S. Bronchialis. Bronchia. Cow, Dog, Swine.

Genus : STEPHANURUS (Stephanos crown, hood, oura tail).
S. Dentatus (*Sclerostoma Pinguicola*. Cysts in mesentery, about spare rib, kidney, liver, etc. Swine.

Genus : UNCINARIA (uncinus hook).
U. Trigonocephala (three cornered head). Small Intestine. Dog, Fox, Cat.
U. Cernua. Small Intestine. Sheep, Goat.
U. Stenocephala. Small Intestine. Dog.
U. Radiata. Duodenum. Calf, Cattle.

Genus : TRICHINA (trix hair).
T. Spiralis. *Mature* in alimentary canal; *immature* in connective tissue of muscles. Man, Pig, Rat, Mouse, Dog, Fox, Cat, Weasel, Badger, Racoon, Boar, Mole, Hedgehog, also Hamster, Guinea-pig, Rabbit, Calf, Lamb, Horse, etc.

Genus : DISPHARAGUS (dis two, pharynx throat). Double pharynx.
D Spiralis. Intestine, connective tissue around gullet. Hen.
D. Uncinatus. Gullet. Duck.
D. Nasutus. Wall of gizzard. Hen, Sparrow. *D. Hamulosus*. Walls of gizzard. Fowls.

Genus : OLLULANUS (ollula smallfoot, anus).
O. Tricuspis (three teeth). *Mature* in gastric mucosa; *immature* in intestine and muscles. Cat and small Rodents.

Genus : SPIROPTERA (speira coil, pteron wing).
S. Recticulala. Wound round muscular or tendinous fibers in neck, shank, etc. Horse.
S. Megastoma. Diseased gastric mucosa. Horse, ass.
S. Microstoma. Gastric contents. Horse, ass.
S. (Gongylonema) Scutata. Æsophagean epithelium. Ox, sheep, pig, horse.
S. Strongylina. Stomach. Pig.
S. Sanguinolenta. Stomach, blood vessels, lungs. Dog.
S. Leporum. Gastric mucosa. Hare, rabbit.
S. Uncinata. Gullet. Goose.
S. Crassicanda. Gizzard. Duck.
S. Hamulosa. Gizzard. Hen.
Simondsia Paradoxa. Cysts in gastric mucosa. Pig.

Genus : STRONGYLUS (stroggylos cylindrical).
S. Gigas. Liver, kidneys, urinary organs. Horse, ox, dog, man.

S. **Filaria.** Trachea, bronchia, lungs. Sheep, goat, camel.
S. **Rufescens.** Lungs, bronchia. Sheep, goat, camel.
S. **Capillaris.** Bronchia and air cells. Goat, sheep, chamois.
S. **Micrurus.** Trachea, bronchia, lungs. Calf.
S. **Pulmonaris.** Bronchia. Calves.
S. **Arnfieldi.** Bronchia, lungs. Horse, ass.
S. **Axei.** Tumors of gastric mucosa. Ass.
S. **Tenuissimus.** Tumors of left gastric mucosa. Horse.
S. **Elongatus.** Trachea, bronchia, lungs. Pig.
S. **Commutatus.** Bronchia. Rabbit, hare.
S. **Pusillus.** Bronchia. Cat.
S. **Ostertagi.** Nodules of mucosa, fourth stomach. Calf. Yearling. . Cattle.
S. **Radiatus.** Small intestine. Colon. Ox.
S. **Filicollis.** Fourth stomach, duodenum. Sheep.
S. **Cervicornis.** Fourth stomach. Lambs, sheep.
S. **Gracilis.** Mucosa. Fourth stomach. Cattle, sheep.
S. **Contortus.** Fourth stomach, duodenum. Sheep.
S. **Convolutus.** Fourth stomach and intestine. Sheep, ox.
S. (**Cooperia**) **Ventricosus.** Small intestine. Sheep, ox.
S. **Venulosus.** Small intestine. Goat.
S. **Strigosus.** Intestine. Rabbit, hare.
S. **Vasorum.** Cavities of heart. Dog.
S. **Subulatus.** Venous blood. Dog.
S. (*Trichostrongylus*) *Retortæformis.* Intestine. Rabbit, hare.
S. **Nodularis.** Gullet, gizzard, intestine. Duck, goose.
S. Tenuis. Goose.
S. **Pergracilis.** Intestines. Grouse, pigeon.
S. **Quadriradiatus.** (**S. Tenuis.** Eberth). Pigeon.

Genus : OSTERTAGIA. Stiles.
O. (*Strongylus*) *Ostertagi.* Nodules of mucosa. Abomasum. Calf, yearling cattle.
O. Circumcincta. Fourth stomach. Sheep, goats, U. S.
O. Trifurcata. Omasum. Sheep, goat, U. S.
O. Marshalli. Abomasum. Sheep, Mont.
O. occidentalis. Abomasum. Sheep, Mont.

Genus : COOPERIA. Giles.
C. Curticei. Strongylus Curticei.
C. punctata. Cattle, Texas.
C. onchophora. Cattle, Texas.
C. pectinata. Cattle, Texas.

Genus : TRICHOSTRONGYLUS. Looss.
T. retortæformis. Intestines. Rabbits.
T. extenuatus. T. gracilis. Abomasum. Cattle, sheep, goats, and other ruminants.
T. Capricola. Goats and sheep, U. S.
T. instabilis.
T. proboluris.
T. Vitrinus.

Genus : OXYURIS (oxys pointed, oura tail).
O. Curvula. Large intestine. Solipeds.
O. Mastigodes. Large intestine. Solipeds.
O. Vermicularis. Large intestine. Man (dog?).
O. Ambigua. Cæcum. Rabbit, hare.
O. Compar. Intestine. Cat (dog?).

Genus : ASCARIS (intestinal worm).
A. Megalocephala (megalos large). Small intestine. Solipeds.
A. Bovis (Vituli). Small intestine. Calf.
A. Ovis. Small intestine. Sheep.
A. Suilla. Small intestine. Swine.
A. Marginata. Small intestine (stomach). Dog.
A. Mystax. Small intestine (stomach). Cat, man.
A. Crassa. Intestine. Duck, goose.
A. Inflexa. Intestine. Hen.
A. Gibbosa. Intestine. Hen.
A. Perspicillium. Intestine. Turkey.
A. Maculosa. Intestine. Pigeon.
A. Dispar. Intestine. Goose.
A. Vesicularis. Cæcum, large intestine. Hen, turkey, peafowl.

Genus : HETERAKIS (ëteros different, àkis point, spiculum).
H. Vesicularis (*Papillosa*). Cæcum, gallinaceæ. Duck.
H. Lineata. Duck.
H. Dispar. Cæcum. Goose.
H. Maculosa (*Columbæ*). Goose, pigeon.
H. Compressa. Intestine. Chicken.
H. Inflexa (*Perspicillium*). Intestine, egg. Hen, turkey, peafowl, pheasant.
H. Differens. Large intestine. Hen.

Genus : PASSALURIS (passalos pig, oura tail).
P. Ambigua. Intestine. Rabbit, hare.

Genus : ŒSOPHAGOSTOMA (Mouth and gullet continuous : no buccal cavity).
Œ. Columbiana. *Mature* in intestines ; *immature* in cysts in intestinal walls, mesentery, liver, etc. Sheep. America.

Œ. Venulosum. Intestine and intestinal walls. Sheep, Goat, Deer.
Œ. Dentatum. Intestine, intestinal walls and liver. Pig, Pecari.
Œ. Inflatum. Intestine, intestinal walls. Ox.

Genus: PHYSALOPTERUS (physallis bladder, pteron wing).
P. Truncata (cut off). Proventriculus. Chicken.
P. Digitata. Stomach. Puma, Cougar, (Cat).

Genus: GLOBOCEPHALUS (round head).
G. Longemucronatus (tail sharp point). Small intestine. Pig.

Genus: RHABDONEMA (rabdos rod or wand). *Strongyloides. Anguillula.*
R. Strongyloides (*Anguillula Intestinalis*) or *Stercoralis.* Man.
R. Longus. Intestines. Sheep.
R. Suis. Intestines. Pig.
R. Cuniculi. Intestine. Rabbit.

BUCCAL AND PHARYNGEAL PARASITES AND MESSMATES OF SOLIPEDS.

Microörganisms in Infectious Diseases.

Saccharomyces Albicans in *Thrush* in sucking foals.
Actinomyces in tongue, lips, etc.
Gutturomyces Equi in guttural pouches (Rivolta).
Horse leech (Hæmopis Sanguisuga) on lips, tongue, cheek, palate, pharynx.
Gray leech (Hirudo-Medicinalis). Algiers and tropics.
Green leech (H. Officinalis). Algiers and tropics.
Trout leech (H. Troctina). Algiers and tropics.
Land leech (H. Ceylonica, H. Tagalla). Ceylon, Philippines.
Larva of Œstrus Duodenalis (Nasalis).

ŒSOPHAGEAL AND GASTRIC PARASITES OF SOLIPEDS.

Larva of Œstrus Equi. Common horse bot. (From largest bot fly).
Larva of Œstrus Hæmorrhoidalis. Bot of rectum. (From red-tailed bot fly).
Larva of Œstrus Pecorum. Bot of rectum. (From bot fly with yellow hairs and black band.
Larva of Œstrus Duodenalis (Nasalis). Bot of pharynx and duodenum. (From bot fly with orange or gray hairs on tail).
Larva of Œstrus Flavipes. Bot of yellow-footed œstrus.
Strongylus Axei. In tumors of gastric mucosa.

S. Minusculus (Tenuissimus). In tumors of right gastric mucosa.

Spiroptera Megastoma. In tumors of right gastric mucosa and gullet.

S. Microstoma. Gastric contents and ulcers.

S. (Gongylonema) Scutata. Œsophagean epithelium.

INTESTINAL PARASITES AND MESSMATES OF SOLIPEDS.

INFUSORIA.

ENTODINIUM BIPALMATUM. Contents of large intestine.
Entodinium Valvatum. Contents of large intestine.
Diplodinium Uncinatum. Contents of large intestines.
Diplodinium Unifasciatum. Contents of large intestine.
Spirodinium Equi. Contents of large intestine.
Triadinium Caudatum. Contents of large intestine.
Globidium Leuckarti. Villi of small intestine.

TAPE-WORMS.

Tænia Perfoliata. Small intestine and cæcum, (colon).
T. Mamillana (Mammiform tænia). Small intestine, (stomach).
T. Plicata (Folded tænia). Small intestine, (stomach).
Cysticercus Fistularis (Pipe-like cyst). Peritoneum.

TREMATODES.

Amphistoma of Collins. Large intestines. India.
Gastrodiscus Sonsini. Small and large intestines, pharynx, gullet, stomach, nose.

NEMATODES.

Ascaris Megalacephala (Large headed ascaris). Small intestines.
Oxyuris Curvula (Curved pointed tailed worm). Large intestines.
Oxyuris Mastigodes (Thread tailed worm). Large intestines.
Sclerostoma Equinum (armed mouthed). Large intestines. Cysts in mucosa, blood vessels.
Sclerostoma Tetracanthum (four toothed). Large intestines.
Filaria Papillosa (Thread worm with papillæ). Peritoneum, aqueous humor, etc.
Anguillula (Rhabdonema Strongyloides). Intestines.

LARVA OF DIPTERA.

Œstrus in passing out and temporarily delayed in bowel.
Helophilus Pendulinus (Rat tailed maggot). Intestines.

PARASITES OF THE MOUTH AND PHARYNX IN RUMINANTS.

Microörganisms of Infectious Diseases.

Saccharomyces Albicans in *thrush* of calves and lambs.
Hæmopis. Leeches of different kinds.
Actinomyces in lips, tongue, cheeks, and pharynx.

PARASITES AND MESSMATES OF ŒSOPHAGUS AND STOMACHS IN RUMINANTS.

Microörganisms of Infectious Diseases.

Infusoria : (Don't appear to be injurious to the host).

Isotricha Prostoma. Long, ciliated, mouth terminal ; in rumen.
I. Intestinalis. Long, ciliated, mouth ventral ; in rumen.
Dystricha Ruminantum. Spiral surface striæ ; in rumen.
Holotrichæ. Entirely ciliated, in hay and in rumen.
Butchlia Parva. Ovoid body, truncated and ciliated in front ; in rumen.
B. Neglecta. Four deep notches at tail, transverse ciliary zones ; in rumen.
B. Lanceolata. Lancet-shaped, distinct neck with cilia ; in rumen.
Ophryoscolex Purkenjei. Flat, rigid, 3 whorls of cilia ; rumen sheep.
O. Mermis. Body ovoid, nude, buccal ciliary whorl ; rumen sheep.
Entodinium Minimum. Elongated, nude, obtuse end, buccal cilia ; rumen sheep.
E. Bursa. Body ovoid, flattened, broad, nude, notched tail, buccal cilia ; rumen sheep.
E. Caudatum. Body ovoid, nude, 3 caudal prolongations, buccal cilia ; rumen sheep.
E. Rostratum. Ovoid, nude, 1 caudal prolongation, buccal cilia ; rumen sheep.
Diplodinium Vortex. 1 circle of buccal, and 3 of caudal cilia ; rumen sheep.
D. Maggii. 2 circles of buccal cilia, 1 caudal (often imperfect); rumen sheep.
D. Bursa. Body cord-like, 1 circle of buccal cilia, tail bilobate ; rumen sheep.
D. Mammosum. Like the last, but with 3 mammiform caudal lobes ; rumen sheep.
D. Dentatum. 2 cephalic rings of cilia, 6 curved caudal denticulations ; rumen sheep.

D. Caudatum. 1 buccal circle of cilia, caudal prolongation; rumen sheep.
D. Ecaudatum. Like the last but without tail; rumen sheep.
D. Rostratum. Like the latter but smaller, 80 μ; rumen sheep.
D. Cattanei. Body long, buccal ciliary ring, several caudal prolongations; rumen sheep.

Sporozoa: **Balbiana Gigantea.** Muscles of pharynx and gullet in sheep, ox, buffalo and goat.

Trematodes: **Amphistoma Conicum.** Ovoid, narrowed toward head, red. Rumen of ox, sheep, etc.
A. Crumeniferum. In zebu.
Gastrodiscus (Polymastos) Sansinoi. Intestine, horse, ass, mule. Egypt, Gaudeloupe.

Nematodes: **Strongylus (Hæmonchus) Contortus.** Abomasum of sheep, goat, argali, chamois, ox.
S. (Nematodirus) Filicollis. Abomasum of sheep and goat.
S. Convolutus. Abomasum of ox and sheep.
Ostertagia Ostertagi. Abomasum calf and yearling.
O. Circumcincta. Abomasum of sheep and goat.
O. Trifurcata. Abomasum of sheep and goat.
Cooperia Curticei. Cattle. Texas.
C. Punctata. Cattle. Texas.
C. Onchophora. Cattle. Texas.
C. Pectinata. Cattle. Texas.
Trichostrongylus Extenuatus. Abomasum ruminants.
T. Capricola. Goat and sheep.
Spiroptera (Gongylonema) Scutatum. In sinuous line in epithelium of gullet in sheep and cattle.

PARASITES AND MESSMATES OF THE INTESTINES IN RUMINANTS.

Microörganisms of Infectious Diseases.

Cryptogams: **Actinomyces.** Intestine of calf.
Saccharomyces Guttulatus in intestinal mucus. Ox and sheep.
Aspergillus Fumigatus in intestinal mucosa and mesenteric glands of ox.

Infusoria: **Lamblia Intestinalis.** Intestinal contents. Sheep.

Sporozoa: **Coccidia perforans and Oviformis.** Intestinal mucosa and contents. Ox, sheep.

Cestodes: **Tænia Denticulata** (Dentated). Small intestine. Ox.
T. Expansa (Broad). Small intestine. Ox, sheep.
T. Alba (White). Small intestine. Sheep, ox.
T. Benedeni. Small intestine. Sheep.
T. Fimbriata (Fringed). Duodenum. Gall ducts. Sheep.
T. Vogti. Small intestine. Sheep.
T. Ovilla (Aculeata). Small intestine. Sheep.
T. Giardi. Small intestine. Sheep.
T. Centripunctata. Small intestine. Sheep.
T. Globipunctata. Small intestine. Sheep.
T. Ovipunctata. Small intestine. Sheep.
T. Capræ. Small intestine. Goat.

Trematodes: *Amphistoma Tuberculatum.* Intestines. Ox. (Hindostan).
Bilharzia Crassa. Mucous papules of intestines and anus. Ox (Egypt, Africa, India).
Distoma Hepaticum and **D. Lanceolatum.** Young in duodenum and peritoneal cyst.

Nematodes: **Ascaris Vituli** (vitulus calf). **A. Bovis.** Small intestine. Ox.
A. Ovis. Small intestine. Sheep.
Strongylus Contortus. Small intestine. Sheep.
S. Radiatus. Small intestine. Ox.
S. Convolutus. Intestine. Sheep, ox.
S. Filicollis (filum thread, collum neck). Duodenum. Sheep.
S. Ventricosus (venter belly, ventricose bulging). Intestine. Ox.
Œsophagostoma Inflatum (inflated neck). Intestine and walls. Ox.
Œ. Venulosum (many veined). Intestine and walls. Sheep, goat, deer.
Œ. Columbianum (Dist. of Col.). Intestine and walls. Sheep.
Sclerostoma Hypostomum (hypo beneath, stoma mouth). Large intestine. Sheep, goat.
Uncinaria Radiata (uncinus a hook). (**Monodontus Phlebotomus**). Duodenum. Calf, ox.
U. Cernua. Small intestine. Sheep, goat.
Trichocephalus Affinis (whip worm, affinis related.) Large intestine. Ox, sheep, goat.
Rhabdonema Longus (rhabdos rod, nema thread). Intestine. Sheep.

PARASITES OF THE MOUTH AND PHARYNX IN SWINE.

Microörganisms of infectious diseases.

Leech. Hemopis.
Spiroptera (Gongylonema) Scutata. In epithelial layer.

PARASITES OF THE GULLET AND STOMACH IN SWINE.

Infusoria: *Trichomonas.* A flagellate organism in contents.

Nematodes: **Spiroptera Strongylina.**
S. (Gongylonema) Scutata. In epithelial layer.
Gnathostoma Hispida (gnathos jaw, hispidus prickly).
Simondsia Paradoxa. In gastric contents and tumors of the mucosa.

PARASITES AND MESSMATES OF INTESTINES IN SWINE.

Infusoria: *Balantidium Coli.* Rectum. Harmless.

Acanthocephala: **Echinorhynchus Gigas** (Echinos sea-urchin rhynchus nose). Duodenum and small intestine generally.

Trematodes: **Distoma Hepaticum.** Embryos in duodenum.
D. Lanceolatum. Embryos in duodenum.

Nematodes: **Ascaris Suis.** Small intestine.
Œsophagostoma Dentatum. Large and small intestine.
Globocephalus Longemucronatus (Globus round, cephale head, mucronatus sharp point). Small intestine.
Trichocephalus Crenatus, (*Dispar*). Whip-worm; crenatus folded. Large intestine.
Trichina Spiralis (Trix hair). Large and small intestine.
Rhabdonema Suis.

PARASITES OF MOUTH, PHARYNX, GULLET AND STOMACH OF DOG.

Microörganisms of Disease.

Leech. Hemopis.

Infusoria: *Monocercomonas Canis* (cercos tail, monos one). Uniflagellate infusoria. Stomach, duodenum.
Œstrus Larva. Stomach from eating horse raw.

Nematodes: **Spiroptera Sanguinolenta.** Blood-hued. Tumors in stomach and gullet.
Ascaris Marginata.

Various tapeworms.

PARASITES AND MESSMATES OF THE INTESTINE IN DOG.

Infusoria: Lamblia Intestinalis.

Sporozoa: **Coccidium Oviforme.** Contents and mucosa.
C. Perforans. Contents and mucosa.
C. Bigeminum. Contents and mucosa.
Cytospermium Villorum Intestinalis Canis? Coccidia of intestinal villi.

Trematodes: **Hemistoma Alatum** (alatus winged).
Distoma Echinatum. (Echinus thorn).
D. Truncatum. Young in intestine.

Cestodes: **Tænia Serrata**: Small Intestine. Larva: Cysticercus Pisiformis, Rabbit.
T. Marginata: Small Intestine. Larva: C. Tenuicollis, Herbivora.
T. Canina (Cucumerina): Small Intestine. Larva: C. in Trichodectes, Louse, Flea.
T. Krabbei: Small Intestine. Larva: C. Tarandi, Reindeer.
T. Coenurus: Small Intestine. Larva: Coenurus Cerebralis, Sheep, Ox.
T. Serialis: Small Intestine. Larva: C. Serialis, Rabbit.
T. Echinococcus: Small Intestine. Larva: Echinococcus Veterinorum, Herbivora, Omnivora.
T. Litterata: (**Lineata, Pseudo-cucumerina, Canis Lagopodis**): Small Intestine.
Bothriocephalus Latus: Small Intestine.
B. Cordatus: Small Intestine.
B. Fuscus: Small Intestine.

Nematodes: **Ascaris Marginata**: Small Intestine.
Oxyuris Vermicularis: Small Intestine.
Uncinaria Trigonocephala (Uncinus hook): Small Intestine.
U. Stenocephala: Small Intestine.
Trichocephalus Depressiusculus (Whip worm): Cæcum.
Filaria Hepatica: (Immature): Mucosa of intestine and bile ducts.

PARASITES OF THE STOMACH OF THE CAT.

Ollulanus Tricuspis (Three toothed): Gastric mucosa.
Ascaris Mystax: In contents.
Taenia Crassicollis (Thick necked): In contents.

PARASITES AND MESSMATES OF THE INTESTINES OF CAT.

Infusoria: Lamblia Intestinalis: Small intestine. Harmless.

Sporozoa: Coccidium Rivolta: Mucosa and contents of bowel.

Trematodes: **Distoma Truncatum**: Young in intestine.
D. Sinense: Young in intestine.

Cestodes: **Tænia Crassicollis**: Small Intestine, Stomach. Larva in liver of rodents, Cyst. Fistularis.
T. Elliptica: Small Intestine.
F. Litterata: Small Intestine.
Bothriocephalus Felis: Small Intestine.

Nematodes: **Acaris Mystax**: Small Intestine.
Oxyuris Compar: Small Intestine.
Uncinaria Trigonocephala: Small Intestine.
Trichosoma Lineare: Small Intestine.
Ollulanus Tricuspis (embryos): Small Intestine.

PARASITES OF MOUTH AND PHARYNX OF RABBIT.

Leeches.
Coccidium.
Aspergillus.

PARASITES AND MESSMATES OF STOMACH OF RABBIT.

Sporozoa: Cryptogam: Saccharomyces Guttulatus: Gastric contents.

Nematodes: **Strongylus Strigosus**: Gastric contents.
Spiroptera Leporum: Gastric mucosa.

PARASITES AND MESSMATES OF INTESTINES OF RABBIT.

Microörganisms of Infectious Diseases.

Cryptogams: Saccharomyces Guttulatus: Intestinal contents.

Infusoria: Lamblia Intestinalis: Duodenal mucus.

Sporozoa: **Coccidium Perforans**: Contents and mucosa.
C. Oviforme: Contents and mucosa.

Cestodes: **Tænia Pectinata**: *T. Rhopaliocephala:* Hare, Rabbit; *T. Wimerosa:* Wild Rabbit; *Dipylidium Leuckarti:* Wild Rabbit; *D. Pectinatum:* Hare; *D. Latissimum:* Wild Rabbit.

Acanthocephala: **Echinorhynchus of Rabbit**: Small Intestine.

Nematodes: **Oxyuris Ambigua**: Large intestine. Rabbit, Hare.
Strongylus Strigosus: Stomach, Cæcum, Colon, Rabbit,
Trichocephalus Unguiculatus (unguis nail, claw); large intestine. Rabbit, Hare.
Anguillula of Rabbit: Small intestine.

PARASITES OF THE INTESTINE OF GUINEA-PIG.

Infusoria: Monocercomonas Caviæ: Large intestine.
Cercomonas Ovalis: Large intestine.
C. Pisiformis: Large intestine.
C. Globosus: Large intestine.

PARASITES OF STOMACH AND INTESTINES OF ELEPHANTS.

Œstrus Elephantis. Stomach.

Trematodes: **Amphistoma Hawkesii**: Intestines.
A. ? Intestines.
A. ? Intestines.

Nematodes: Round worm found by Steel in gastric mucosa and submucosa.
Round worm in stomach and intestine.
Three Round worms in intestines.

PARASITES OF PHARYNX, GULLET, CROP AND STOMACH OF BIRDS.

Microörganisms of Infectious Diseases.

Fungus: **Aspergillus Fumigatus**: Gullet, (mouth, lungs, liver, intestine, kidneys): young pigeons.

Infusorium: Cercomonas Gallinæ: Pharynx, gullet, crop; pullets and young pigeons.

Sporozoön: **Coccidia**: Comb, wattles, mouth, throat, crop, etc.; young chicks and doves.
Cocidium Tenellum.

Trematodes: **Distoma (Mesogonimus) Pellucidum** (pellucid). Gullet: Hen.

Nematodes: **Dispharagus Spiralis** (Two pharynges). Cysts in gullet: Hen.
D. Nasutus (Large nosed). Nodules of gizzard: Hen, Sparrow.
D. Uncinatus. Gullet: Duck.
Spiroptera Uncinata (Hooked). Gullet: Goose.
S. Crassicanda. Gizzard: Duck.

S. Hamulosa. Gizzard: Hen. (Hamulus, small hook.)
Spiroptera (Gongylonema) Ingluvicola of hen.
Tropisurus Fissispinus (Keel, Tail). Submucus cysts in gullet: Duck.
T. Inflatus (Inflated). Submucous cysts in gullet: Duck.
Hystrichis Tricolor (Barbed whip). Proventriculus: Duck.
H. Tubifex. Nodules of gullet: Duck.
H. Pachycepalus (Thick-head). Mucosa of proventriculus: Swan.
Trichosoma Contortum (Hair-body, twisted). Contents and submucosa, gullet: Duck, goose, palmipedes.
Physalopterus Truncata (Bladder-winged, cut off). Proventriculus: Hen.
Strongylus Nodularis. Mucosa and submucosa proventriculus: Goose.
Embryos of filaria, etc., (Bakody). Muscles of Gizzard: Hen.

PARASITES OF THE INTESTINES OF BIRDS.

Microörganisms of Infectious Diseases.

Fungus: **Aspergillus Fumigatus** Intestinal mucosa: Young pigeons.

Infusoria: *Trichomonas Eberthi* (one flagellum). Intestinal follicles: Hen, Duck, etc.
T. Calumbæ: Small intestine. Pigeons.
Monocercomonas Anatis (T. Eberthi ?). Cæcum. Duck.

Sporozoa: **Coccidium Perforans** *Gregarina Avium Intestinalis*): Intestines. Chickens.
C. Tenellum. Intestines.

Tape-worms: **Tænia Infundibuliformis.** (Funnel-shaped). Hen, (Duck ?), Cysticercus in Earthworm—Allolobophora fœtida (Grassi).
T. Cuneata (wedge like). Hen, cysticercus host like last (Grassi).
T. Exilis (slender). Hen.
T. (Davainea) Tetragona (four cornered head). Cysts in intestinal walls. Hen.
T. Fasciolaris (band): *T. Malleus.* Hen, Duck.
T. Cesticillus (girdle). Hen.
T. Proglottina (segmented). Hen, Cysticercus in snail —Limax cinerus, L. agrestis, L. variegatus.
T. Bothrioplitis. Hen. Cysticercus in snails? Helix

carthusianella, H. maculosa.
T. Echinobothrida (hooked). Hen, (Last 3 very similar).
T. Cantaniana. Turkey, Pheasant.
T. Friedbergeri. Pheasant.
M. Crassula (thick leaf). Pigeon.
T. Anatina. Duck.
T. Sinuosa (waving). Duck, Goose.
T. Gracilis (delicate). Duck. Cysticercus in Condona rostrata, a crustacean.
T. Coronula (crowned). Duck.
T. Megalops (large). Duck.
T. Spherocephala. Pigeon.
T. Conica (conical rostellum). Duck.
T. Imbutiformis. Duck.
T. Lanceolata (lancet-shaped). Goose.
T. Fasciata (banded). Goose.
T. Setigera (with tail). Goose, Swan.
T. Trilineata (three lines). Duck.
T. Aquabilis. Swan.
Bothriocephalus Longicollis (long neck). Hen.

Trematodes : Monostoma Verrucosum (one orifice : warty). Hen, Duck Goose.
M. Caryophyllinum (Clove like), Duck.
M. Attenuatum (narrow). Goose.
Distoma Oxycephalum (two orifices, pointed head). Hen, Duck.
D. Dilatatum (broad). Hen.
D. Lineare (narrow, linear). Hen.
D. Armatum (with spines). Hen.
D. Ovatum (oval). Duck, Goose, Hen, Eggs.
D. (*Mesogonimus*) *Commutatum* (changeable). Hen, Turkey.
D. Columbae. Pigeon.
D. Echinatum (hooked). Duck, (Dog).
Holostoma Erraticum (wandering). Duck, Swan. Larva in molluscs, fish and other trematodes.

Acanthocephala : **Echinorhynchus Polymorphus** (hook snout). Duck, Swan, Goose. Larva in fresh water shrimps (gammarus pulex) and cray fish.
E. Filicollis (narrow neck). Duck.
E. Sphæracephalus (sphere-like head). Duck.

Nematodes : **Ascaris Gibbosa** (gibbous-humped). Hen.
A. Crassa (thick). Duck, Goose.
Heterakis Papillosa (other point, with papillæ). Hen, Turkey, Guinea-fowl, Pheasant, Peacock, Duck, Goose.

H. Differens. Hen.
H. Vesiculares. Pheasant. (Resembles papillosa).
H. Inflexa (bent). Hen, Turkey.
H. Compressa (flattened). Hen.
H. Lineata (striated). Duck.
H. Maculosa (*Columbæ*). (Spotted) Pigeon.
H. Dispar (apart). Goose.
Trichosoma Longicolle (hair-body, long neck). Hen, Pheasant.
T. Annulatum (ringed). Hen.
T. Collare (marked neck). Hen.
T. Tenuissimum (*Columbæ*) (delicate). Pigeon.
T. Brevicolle (short neck). Goose.
Dispharagus Spiralis (double pharynx). Hen.
Strongylus Tenuis (small). Goose.
S. Nodularis. Duck, Goose.
S. Quadriradiatus. Pigeon.
Filaria Clava (scion or shoot). Pigeon (connective tissue).
F. Cygni. Swan.
Rhabdonema. Strongyloides (*Anguillula*). Hen.

PARASITES OF THE STOMACH AND INTESTINES.

BACTERIA and INFUSORIA are common in the intestines of animals. The BACTERIA met with are either harmless ferments, or in certain morbid and debilitated states of the mucosa, they may become pathogenic as noted under the various diseases of the mucosa. In certain cases they constitute the essential factor of a contagious disease, and will be treated in connection with infectious maladies. The INFUSORIA are *flagellate* or *ciliated.* The *flagellate* include: 1st, *Monocercomonas* which has four flagellæ attached to its anterior end, three of them extended forward, and one backward and exceeding the body in length: 2nd, *trichomonas* has either four or five anterior flagellæ, only one of which is projected backward, attached to the body by a delicate membrane, and with its free posterior end projecting beyond the body backward; 3d, *Lamblia* furnished with a large depressed sucker anteriorly and two flagellæ projecting from its posterior extremity.

The *ciliata* are differentiated according to the arrangement of the cilia on the surface of the body.

Cilia covering the whole body.	All the cilia short and equal.	Holotrichæ
	Has an extra row of long cilia around the mouth.	Heterotrichæ
Cilia on the ventral aspect only.		Hypotrichæ
Cilia as a crown around the mouth : often also as a girdle		Peritrichæ

In ruminants, carnivora, rodents and birds *coccidia* or *psorospermiæ* cause disease of the bowels.

VERMES. HELMINTHES. WORMS.

Intestinal worms are divided into groups as follows : 1, TAPEWORMS (*Cestoids*) ; 2, FLUKES (*Trematoids*) ; 3, THORNHEADED WORMS (*Acanthocephala*) ; 4, ROUND WORMS (*Nematoids*).

TAPEWORMS. CESTOIDS (*Kestos, festooned*).

Flat body in segments originating in striæ in neck, rounded head, tetragonal owing to four suckers, and often protractile proboscis and hooklets. Segments increase toward caudal end, becoming sexually mature and oviger-ous ; longitudinal and transverse muscular fibres ; two pairs, dorsal and ventral canals, and two nerves near borders. Each segment hermaphrodite. Tænia and bothriocephalus. Stages of development : 1. *Mature tape-worm* (tænia, strobila) ; 2. *Detached ripe segment* (proglottis); 3. *Ovum ;* 4. *Six-hooked embryo* (proscolex) ; 5. Larvæ (bladder-worm, hydatid, scolex). Armed tæniæ ; unarmed tæniæ. Sub-divisions of armed tæniæ : (a) Cystotænia, cyst continuous with the head ; (b) Cystoidotænia, with caudal end enlarged by budding, and cyst only slightly developed. *Cystotæniæ* are (a) *Cysticercus*, larva with one head and cyst from one ovum ; (b) *cænurus*, many heads in one cyst from one ovum ; (c) *echinococcus*, many cysts from the first parent cyst, and many of these develop one head each, representing a future tape-worm. Unarmed tænia. *Flat-headed tape worms : Bothriocephala*, lateral slit-like suckers in margins of head. Mostly in fish and fish-eating carnivora.

This order of worms is characterized by its flat body, made up of a number of segments joined end to end and preceded by a small head, rendered angular by a row of projecting suckers, and often furnished with a protractile proboscis, and one or two rows of hooklets, by which as well as by the suckers, they attach themselves to the mucosa. The segments in the narrow neck are represented by simple transverse striæ, which become wider apart the more distant they are from the head, until the segments

are fully developed toward the caudal end. The head is round, or more usually four-sided, the suckers forming the projecting angles. The body of the worm is made up of stellate anastomosing cells, the whole covered by a homogeneous cuticle, in which as well as in the interior, calcareous encrustations are not uncommon. Beneath the cuticle is a layer of contractile cells, then a layer of longitudinal muscular fibres and finally one of transeverse fibres. There is no true digestive apparatus, but two pairs of canals dorsal and ventral, extend back, through the successive segments near their lateral borders, and open on the posterior border of the terminal segment. Two lateral nervous cords run the entire length of the body and are united by a transverse band at the head.

Sexually, each segment is independent, being furnished with both male and female orgaus, opening at one of the borders (Hermaphrodite). The male organs are the first to be developed so that the young segments immediately back of the head are exclusively masculine. Later the female organs appear, to undergo impregnation and when filled to repletion with ova, completely predominate over and overshadow the male organs. The male apparatus consists of a series of pyriform testicles opening into a sperm duct and penis which may project from the genital orifice. The female apparatus consists in ovaries connected with oviducts, which branch in a variable degree in different species, but in some like the beef tape-worm, come to fill the whole interior of the segments, and virtually obliterate the male organs.

Two great primary divisions of tape-worms are met with: 1. TÆNIA with a globular or teragonal head, and 2. BOTHRIOCEPHALUS with flat head perforated at each margin by an opening or bothrion.

Tænia. The tænia passes through five different successive stages of existence in its progress from the ovum to the ripe egg-bearing segment. These are as follows, beginning with the familiar tape-worm:

1. **Tape-worm** (STROBILA). This has the characters already described, and lives in the intestinal canal or some communicating passage like the gall ducts.

2. **Detached Ripe Segment** (PROGLOTTIS). This is a flat quadrangular white segment found on the newly passed fæces or

in their vicinity, and progressing by a worm-like motion. It is literally a bag of ova and when swallowed by a suitable host, or when its ova are taken in with the water or food, it is in the line of further development. If taken in by an unsuitable host, it perishes.

3. The **Ovum** set free by the digestion of the proglottis in the stomach of the vertebrate or invertebrate host, soon hatches out an ovoid *embryo* (*proscolex*) furnished at one end with six hooklets for boring purposes.

4. **Proscolex.** The 6-hooked embryo hatched from the egg, at once sets about boring into the tissues of its host, and if it has been successful in entering the proper host, and if it should reach the particular organ suited to its development through its next stage, it forms the *cystic larva* or *scolex*.

5. **Larva, Hydatid Bladder-worm, Scolex.** Becoming embedded in a tissue or organ of its new host, the embryo grows into a cystic organism, developing one or more heads attached to its sac of clear or milky fluid, and encreases at the expense of the surrounding tissue, but never acquires reproductive organs, nor any feature of the mature intestinal worm except the head which exactly represents that of the fully developed tapeworm. It is only when the animal, which acts as host to the larva, is devoured by another animal adapted to entertain this particular parasite in its mature form, that it is set free by the digestion of the tissues around it and grows into a tænia or strobila. The caudal sac disappears, the neck becomes gradually elongated and segmentation commences, being first indicated by the formation of transverse striæ behind the head which become more and more separated, until distinct, sexually-mature segments are formed. It is now a tape-worm or strobila and grows to a varying length determined by its species, and drops off at intervals its ripe ovigerous segments from its caudal extremity.

Divisions of Tænia. The tænia are divided into **armed** and **unarmed** according as they are or are not provided with a double circle of hooklets on the proboscis. The **armed** are sub-divided into: (1) Those which in their larval state have the caudal vesicle proceeding from the head or proscolex by a simple encrease and modification of structure without any new independ-

ent part. These are known as the **cystotæniæ**; (2) Those in which the caudal portion is enlarged by budding and the formation of an additional part or *blastogene*, which retains its embryonic structure. The caudal vesicle is only slightly developed so that the larva retains more of the appearance of a tænia. When it passes into the condition of the tænia the *blastogene* is sloughed off. These are known as **cystoidotæniæ**. This larva lives in invertebrate animals.

The **cystotæniæ** are divided into the **cysticerci, cœnuri,** and **echinococci**, differentiated by their respective mode of development in the larval or cystic stage.

The **cysticercus** has a well developed but simple caudal sac bearing only a single head which may become retracted and invaginated within the sac leaving only a small opening at the point of involution, or it may be projected outward into the surrounding tissue and produce more or less irritation. Two may lie side by side enclosed in a common outer sac, but two heads are never developed from the same inner sac, as is the case with **cœnurus**. The single head is seen as a white point through the transparent sac.

The **cœnurus** is seen as a semi-transparent cyst developed from a single proscolex, as in the case of the cysticercus, but in place of a single head, it develops on its inner surface many (100 to 200) smaller sacs like large pin heads, each containing its independent head which can be invaginated into its special sac, or projected outward into the surrounding tissues. The *cœnurus* can, therefore, multiply in the cystic form outside the ordinary mode of generation, and while a cysticercus ovum can develop into but one tape-worm, the cœnurus can produce 100 or more.

The **echinococcus** is also characterized by the power of increase in the cystic form. The original cyst into which the proscolex develops, can produce in its interior a number of daughter cysts (proligerous vesicles) each of which can develop several heads. The secondary cysts of the cœnurus remain of small size and individually develop but one head only, while the secondary echinococcus cyst may grow to a large size and each develop a number of heads. Thus in the echinococcus cyst it is common to find several heads attached to the same entocyst, and some detached and floating free in the liquid.

It will be seen that the cysticercus tænia can increase by ova only, while both cœnurus and echinococcus can multiply also through multiplication of the larva or cyst.

Unarmed Tape-worms. (Anoplotænia, a privative, oplon weapon). The characteristic of this form is the absence of rostrum and hooklets in both larval and tænia forms. With the single exception of the tænia litterata of the dog, they have been found in the herbivora only, and as fully mature tæniæ. Their migrations and their hosts in the larval or cystic form remain to be discovered.

Tapeworms have been further divided into the following: (Braun, Railliet).

Tæniæ. These are large, armed or unarmed, and with their ripe proglottides longer than broad. In development the uterus first appears as a median, undivided tube extended from before backward, and this developes lateral branches more or less numerous, and, it may be, smaller subsidiary branches. As these grow and become filled with multiplying ova, the male organs and ovary atrophy and disappear gradually. The *larval forms* are as above stated, *cysticerci*, *coenuri* or *echinococci*, developing as a rule in herbivorous or omnivorous hosts. The *strobila* are largely found in carnivorous or omnivorous hosts.

Examples: T. Solium (pork tapeworm), *T. Saginata* (beef tapeworm), *T. Serrata*, *T. Marginata*, *T. Coenurus*, *T. Serialis*, *T. Echinococcus*, etc.

Davainea. Small tapeworms with long proboscis (rostellum) often retractile, and provided in the young stage with many hooklets which may be deciduous disappearing with growth. Genital pores unilateral, or alternating irregularly. Eggs in capsules. Evolution unknown.

Blanchard in 1891 established this order for D. Madagascariensis.

Hymenolepis (hymen fibrous structure, lepis skin).

Scolex small, proboscis protractile and retractile, armed with hooks, head with four opposing suckers, unarmed. Genital pore single on the left margin of each proglottis; three testes. Ripe proglottis entirely filled with branching, ovigerous uterus. Eggs spherical or conical, with three investing membranes. Larva a cercocystis (cercos tail, filament.)

The group is represented by *H.* (*Tænia*) ***Nana*** of the human intestine, the *H. Murinum* of the rat and the *H. Minuta* which infests both man and rat in the mature (strobila) form. Grassi considers the *nana* and *murinum* as identical. The larva is found in many insects, notably in the cockchafer.

Dipylidium (dis double, pyles a small gate).

This has rostellum retractile and furnished with several rows of alternating hooks. Genital organs double with two openings on the right and left margins of each proglottis. Uterus at first reticulated forming saccules, each holding one or more ova. Eggs with double membrane. Larva a cysticercus or onchosphere (ογκος tumor, sphaire sphere).

Example. Dipylidium Caninum.

Birds harbor a great variety of tænia, of the cystic forms and migrations of which, we are as yet mostly in ignorance.

Flat headed Tape-worms (**Bothriocephalus**, ***bothros a hole, cephale, head***). These are characterized first by having the head flat in place of globular or tetragonal, and second by the presence on each lateral margin of the head of a depression or groove representing a sucking disc. The generative organs are much less developed than in the true tape-worms, and they produce relatively fewer ova. In experiments the tænia form has appeared to be developed direct from the egg in the intestine of its host, and as the parasite thus escapes the dangers of destruction to which the true tape-worm is exposed through failure to find its appropriate host in its larval form and again in its mature state, it has a compensation for the paucity of ova. The bothriocephala are mostly the parasites of fish, but a certain number find hosts in man and fish eating carnivora.

FLUKES OR TREMATODES. TREMATODA.

Soft, flat, or conical worms, longer than broad: mouth terminal and surrounded by a muscular, oral sucker turned slightly ventrad. A second sucker in the median line, ventral aspect, is near the head in the fasciolidæ, but near the tail in the amphistomidæ. Skin more or less spiny, or tuberculated. A true digestive system is represented by the mouth, usually a pharyngeal bulb, œsophagus and two cæca, branching freely in

the fasciolidæ, but not provided with an anus. The fasciolidæ and amphistomidæ are hermaphrodite, male and female organs being present in the same individual, while in the blood flukes (schistosominæ) the sexes are in different individuals. The genital pore situated ventrally in the median line presents, in the hermaphrodite forms a *penis* or cirrus pouch lying close to the vulva, retractile and protractile, and receiving the semen through two ejaculatory ducts from the vesiculæ seminales, and testicles. The testicles, usually double, are round, lobed or branched. The *vulva* connects internally with a canal (metraterm) and uterus, the latter usually closely folded upon itself, and connected through a round organ (shell gland) with the vitellogenous ducts and Laurer's canal. The vitellogenous ducts are in two branching systems, one occupying each lateral half of the body (right and left) and form the yolk cells which contribute with the ovum proper to form the eggs. Laurer's canal runs dorsad in curves and opens on the surface of the back, by a minute orifice.

The *intestinal cæca*, devoid of a direct excretory orifice, are lined by cylindroid epithelium which after the fashion of amœbæ send out pseudopoda, which surround the particles of ingesta, to be used up in an *intra cellular digestion*. The waste products escape from the body through the system of *excretory canals*. These last originate in radicals in two systems one occupying the the right and the other the left half of the body, and empty in the median line into a central duct which opens through a small orifice in the middle of the caudal end. The branches of these excretory canals anastomose freely among themselves, and also across the median line with those on the other side of the body.

The nervous system is represented by two ganglia situated on the right and left of the pharynx and connected with each other by a dorsal commissure from which pass off numerous nervous trunks going to different parts of the body. The two main trunks extend backward on the right and left sides of the median line, nearer to the ventral than the dorsal aspect of the body, giving off branches in their course.

The *evolution* of the fluke is remarkable in necessitating (between the ovum and the mature trematode capable of survival in the same habitat and host as its parent), a series of inter-

mediate forms produced by parthenogenesis (virgin birth) and each requiring its own peculiar host or environment. There is: 1. The *ovum* which is incapable of development in the host of its immediate parent; 2. The *ciliated embryo* (*micracidium*) swimming freely in fresh water; 3. The *brood capsule* (*sporocyst*) in the body of an invertebrate (mollusc) into which the micracidium has bored its way; 4. These form in their interior a brood of secondary cysts (*rediæ*) which are usually found in the nutritious liver parenchyma of the invertebrate: two or more successive generations of *rediæ* appear in case the season is unsuited to a free habitat outside the body of the mollusc; 5. The *young fluke* (*cercaria*) which bursts from the body of the mollusc and by means of a natatory tail, swimming freely in water; 6. The *cercaria encysts* itself in a glutinous envelope on the leaves and stems of aquatic plants; 7. The *incysted cercaria* when swallowed by a suitable host is further developed into the sexually mature fluke.

(See, Parasites of the Liver: Distoma Hepaticam).

DIVISIONS OF TREMATODA.

Trematodes parasitic in Domestic Animals are divided into the following families:

I. **Fasciolidæ**: Flat membranous flukes having two sucking discs, oral and ventral, the latter in the anterior part of the body.

II. **Amphistomidæ**: Having the ventral sucker at the caudal end.

I. The **Fasciolidæ** have been divided into the subfamilies of:

1. **Monostomidæ** (μονος one) with one sucker.
2. **Fasciolinæ** (**Distomidæ**) with two suckers.
3. **Shistosominæ**: Sexes in separate individuals: Body of male cleft to clasp that of the female.

1. The **Monostomidæ** (one sucker) include the following:

a. Monostoma: Sucker in the anterior part of the body, small, muscular, with the mouth in the centre of the cup. It includes the following species: *M. Attenuatum* (goose), *M. Caryophillinum* (duck), *M. Mutabile* (goose), *M. Triseriale* (goose), *M. Verrucosum* (duck).

b. Holostoma: Cephalic end separated by a deep constriction and distended into a capacious hollow cup opening in front and acting as a sucker. Example, *H. Erraticum* (duck).

c. Hemistoma. Differs from *holostoma* in having the oral cap cut off obliquely so that the oral orifice is deflected from the cephalic axis. Ex. *H. Alatum* (dog).

2. The **Fasciolinæ**: **Distomidæ**: These have two sucking discs, oral and ventral, the latter in the anterior part of the body. They have the following genera:

a. Agamodistomum. A sexually immature fluke represented by *A. Suis* in the muscles of pigs.

b. Distoma. Fasciola. (Δις twice). Is flattened, leaf-like, pale brown, with two suckers, oral and ventral (acetabulum) the latter in the anterior third of the body, digestive organs branching freely and extending to the caudal end, testicles and ovary ramified, ovum elliptical, with operculum at one end, segmentation but no embryonic development until laid and expelled from the body of the host. Ex. *D. Hepaticum*, *D. Texicanum*, *D. Giganteum*, *D. Hepaticum augusta*, *D. Hepaticum Ægyptiaca*, *D. Hepatica caviae*, etc.

c. Dicrocoelium. Body smaller than Distoma, intestinal cæca simple (unbranched) but extending into the posterior part of the body; œsophagus short; genital pore near bifurcation of the digestive canal; two testicles (lobed or not) close to acetabulum; ovary caudad of testicles; uterine coils fill the posterior part of the body. Ex. *D. Lanceolatum*, *D. Pancreaticum.*

d. Mesogonimus is distinguished from Distoma in that the genital orifices are behind the ventral sucker, which is sessile. Hermaphrodite. Ex. *M. Pellucidus*, *M. Commutatus.*

e. Cephalogonimus. Differs from *Distoma* in having the genital openings, above and to the side of the oral sucker. Hermaphrodite. Specimen found in the gullet of a fowl.

3. Subfamily **Schistosominæ. Bilharzia. Blood Flukes.**
These differ from other flukes in the absence of hermaphrodism. The two sexes are in separate individuals. Body of the male has a cleft almost throughout its whole length in which the more slender body of the female is habitually clasped. Ex. *Bilharzia Hæmatobia.* Bilharzia Cervi (Bovis).

II. **Amphistomidæ.** (αμφι on both sides, στομα mouth).
These are flukes with thick, solid, muscular bodies, oval, cylindrical, or conical and sometimes slightly curved. The ventral sucker is at the caudal end. Hermaphrodite. Ex. *Amphistoma Conicum* (*Cervi*), *A. Explanatum*, *A. Bothriophorus.*

Gastrodiscus. This agrees with the *Amphistoma* in having the ventral sucker at the posterior border of the body. It has further a number of small papilla-suckers scattered over its ventral surface. Ex. *G. Sonsinoi* (Polymastos).

The trematodes have been described as liver parasites.

ACANTHOCEPHALA. HOOK-HEADED. (*Acantha a thorn, cephale head*).

Cylindroid worms; no true digestive apparatus; males and females in separate individuals; larval stage in separate genus; protractile, conical proboscis armed with hooks.

These are cylindroid worms, which differ, however, from the true round worms (nematoids) by the absence of any distinct digestive apparatus, nourishment taking place, by imbibition through the integument. They resemble the round worms in having the sexes in different individuals. The males have two ovoid testicles the efferent ducts of which unite in a common canal and single penis. The female has single ovary and long oviduct opening at the posterior end of the body. Like as in the tænia, the embryos of the acanthocephala have to pass through a larval stage, encysted in the body of another animal (invertebrate), which being devoured by a suitable fish, bird or mammal, affords the opportunity for the development of the parasite to the mature condition.

The larval stage has been observed in a mollusc and in different crustaceans.

The most characteristic feature of the acanthocephala, is the protractile conical proboscis surrounded by several rows of recurved hooks by which the worm attaches itself to the mucosa of its host.

NEMATOIDS. ROUND WORMS. (*Nema* cord, eidos form).

Cylindroid form; digestive apparatus; sexes apart in different individuals; water vascular canals; nerves from glanglia at gullet; oviparous, viviparous, or ovoviviparous; most, without alternate generation, develop from ovum to maturity in one host. *Division:* Trichosoma, trichocephalus, filaria, spiroptera, dispharagus, ascaris, heterakis, oxyuris, strongylus, sclerostoma, uncinaria, œsophagostoma, stephanurus, physaloptera, globocephalus, syngamus, gnathostoma, ollulanus, trichina, rhabdonema.

The true round worms are easily distinguished by their cylindroid form, by the possession of true digestive organs and by the separation of the sexes in different individuals. They have a set of water vascular canals, two on each side of the body communicating at the level of the œsophagus, also a nervous system composed of two ganglia situated in the two sides of the gullet, connected by two transverse branches, and sending nerves forward into the head and backward on the two sides of the body. They are oviparous, viviparous or ovoviviparous. The embryos generally develop in the higher animals without any alternate generation, such as takes place in the cestoids and trematoids, yet in certain species (trichina, sclerostoma, eustrongylus) the young, sexually immature worms may live for a time in the blood-vessel or encysted in solid tissues of the same host or another. The characteristic features of the different groups and genera of round worms may be given as follows:

SECT. I. WHIP-WORMS. CHARACTERS.

Body long; in two distinct parts of unequal thickness; mouth very small, round, anus almost terminal. Spiculum single. Ovum with round end-extension.

Genus: Trichosoma (trix hair, soma body), HAIR BODY. Thickness to length as 1:150 to 1:400. Short thick anterior

part containing œsophagus and anterior part of intestine; caudal, hair-like part has intestine and generative organs. Anus terminal. One spiculum with extensible membranous sheath. Vulva at junction of thick and thin parts of body. Ova elliptical with clear translucent button-shaped enlargement at each end.

Genus: **Tricocephalus** (trix hair, cephale head), HAIR HEAD, WHIPWORM. Long hair-like anterior part contains œsophagus or moniliform part of intestine; short posterior portion, suddenly greatly enlarged has intestine and generative organs. Anus terminal. Spiculum single in membranous sheath. Vulva at junction of thick and thin portions of body. Ova oblong with short neck at each end.

SECT. II. THREAD-WORMS. CHARACTERS.

Body, long, delicate, thread-like; mouth round or triangular, with or without papillæ; no salient lobes. Two unequal spiculæ.

Genus: **Filaria,** (filum thread) **Thread-worms.** Long, thin, breadth to length as 1:80 or 1:500, cylindrical; anus terminal or nearly so. Main spiculum very long and twisted, short spiculum twisted and obliquely striated. Vulva close to head. Ova slightly elliptical. Oviparous or viviparous.

Genus: **Spiroptera,** (speira coil, pteron wing). Body cylindroid or uneven in thickness, mouth round, often ventricle and cæcum. Anus in front of caudal extremity. Skin with transverse striæ. Tail spiral in male, straight in female. Majority burrow in the œsophagean or gastric mucosa.

Genus: **Dispharagus.** Body long, slender; mouth round; œsophagus in two parts, connected behind with a cylindroid ventriculus. Tail usually in spiral. Two spicula. In mucosa of gullet or stomach.

Genus: **Ascaris.** (Intestinal worm). Body very thick, cylindroid, narrowed toward each end; mouth triangular, with three labia having thick muscles; no pharyngeal enlargement; intestine straight; males with 2 spicula; vulva in front of the middle of the body; ova globular or nearly so. Live in small intestine of mammals.

Genus: **Heterakis** (éteros other, äkis spiculum, point). Separated from the Ascarides by Dugardin because the second spiculum is very small or absent. Body like ascaris, labial lobes less pronounced, notches between more shallow; pharynx separated from œsophagus by a horny zone; stomach larger than in ascaris. Live in intestines of birds. Very common.

Genus: **Oxyuris**, (oxys sharp, pointed, oura tail). Body cylindroid or fusiform, tail in sharp point; mouth round when closed, triangular and trilobate when open; œsophagus cylindroid; stomach large with hard corneous lining like a gizzard; anus in front of tail; vulva in anterior fourth or third of body. Male with two spicula, the posterior very small, in a membranous pouch.

Genus: **Strongylus**. (Stroggylus cylindrical). Body cylindroid, thickness to length as 1:35 or 1:130, usually narrower toward the head; mouth triangular or round, with or without papillæ; skin transversely striated; œsophagus club-shaped, enlarged behind. Two spicula of equal length; vulva near the middle of the body. Anus not terminal.

Genus: **Ostertagia.** Named after Ostertag. Important characters of this genus are the presence of cervical and prebursal papillæ; the two ventral rays of the bursa lie near each other with their tips corresponding to a more or less marked notch in the edge of the bursa; an accessory bursal membrane beneath the other membrane, and attached to the caudal end of the body or its dorsal aspect; a second much smaller spiculum may be either present or absent.

Genus: **Cooperia.** After Cooper Curtice. Characterized by its relatively thick head, the cuticle of which is annulated and often forms a visicular swelling; by the absence of cervical and prebursal papillæ; by a peculiar beaded appearance of the cuticle along the longitudinal lines; by the wide separation of the tips of the ventro-ventral ray from the latero-ventral ray, in the bursa; by the peculiar branching of the dorsal ray into two prominent main branches curved to form a lyre shaped or horse shoe

shaped structure, each with a branch which originates near the junction of the main branch with the stem and extends ventrally in a vesicular swelling on the inner surface of the bursa; and by the absence of a second spiculum.

Genus: **Trichostrongylus.** (Trix hair. Looss). These have been classed together because with the general characters of the strongylus they are much smaller, being at once shorter and of a hair-like tenuity.

Genus: **Sclerostoma** (scleros hard, armed, stoma month). This is the type of all worms with chitinous or horny armature or teeth by which they penetrate the tissues and suck blood. Body white or brown, cylindroid, male narrowed toward the head, female toward both ends. Mouth round, open, furnished with hard, chitinous ring or rings, or sharp pointed teeth; male with two nearly terminal spicula and large membranous pouch. Anus in front of caudal point. Vulva two-thirds of the length from the head, ova globular or nearly so. Mature in large intestines of mammals.

Genus: **Uncinaria,** (uncinus hook). So named because its head is sharply curved dorsad. The mouth, round, opens dorsad with horny lining, two to four sharp, curved teeth projecting from its ventral wall internally, and opposing plates above often dentated.

Genus: **Ollulanus.** Mouth urn-shaped with chitinous lining, a muscular œsophagus, and in the male two short spicula in a bilobed membranous pouch. Mature in cat's stomach; immature in muscles, etc.

Genus: **Œsophagostoma.** Marked by the absence of any mouth capsule, the orifice being directly continuous into the œsophagus. Mouth has papillæ dorsal, ventral and lateral, a chitinous, dentated ring. Male with two spicula in ample membranous pouch. Vulva in front of anus and near the pointed tail. Ova elliptical. Mature in the intestines of mammals.

Genus: **Stephanurus,** (stephanos crown, oura tail). Body cylindroid, narrowed toward head; mouth round with two large and four smaller teeth; male with single spiculum, in large five lobed membranous pouch. Female with in-

flected, pointed tail, having a tubercle on each side. Known only as encysted in connective tissue of pig.

Genus : **Physaloptera**, (physallis bladder, pteron wing). Mouth with two prominent lips, each bearing three papillæ externally and teeth internally. The caudal pouch of the male is closed or bladder-like, and covers the base of the tail. Oviparous. Found in intestine in birds.

Genus : **Globocephalus**, (globos round, cephale head). Head spherical, transparent. Mouth round with smooth marginal ring. Buccal cavity has two horny rings, anterior and posterior, with four horny connecting beams. Found in intestines of pig.

Genus : **Syngamus**, (syn with, gamos marriage). Copulation permanent, the caudal end of the male being always attached to the vulva of the female, so that they appear as a forked worm. Mouth large and held open by the hard chitinous capsule of the buccal cavity. Male one-third the length of the female, has two spicula. Vulva in anterior third. In air passages of birds.

Genus : **Gnathostoma**, (gnathos jaw, stoma mouth). **Cheiracanthus** (cheir hand, acantha thorn). Cylindroid worm with front of body covered with scabs having recurved spines. Body tapers to a caudal point. Named from the jaw-like armed mouth by which it fastens itself to the gastric mucosa. In pig, dog and cat.

Genus : **Trichina**, (trix hair). Minute worms, $\frac{1}{6}$ inch long, tapering in anterior half, anus terminal, single spiculum. mature in bowels. Ovoviviparous; embryos migrate into muscles, where they are encysted and sexually immature. Found in man, pig, rat and other mammals.

Genus : **Rhabdonema** (rabdos rod, wand). **Strongyloides** cylinder shaped. **Anguillula** Eel-like. Very small thread worms, the females of which only are found in the bowels, and produce embryos, possibly by parthenogenesis. As found in the fæces of the same host, there are males and females which copulate and produce embryos, but these only attain maturity when they enter the mammal or in case they are kept in a thermostat at the mammalian temperature.

PARASITES OF THE ŒSOPHAGUS.

Œstrus: Equi and *Hæmorrhoidalis* ; *Hyperderma Bovis* ; *Spiroptera Scutata:* Following a zigzag line in epithelium of thoracic part. Ox, horse. *Spiroptera Pulchra*, tongue, pharynx, pig. *Trichosoma Contortum*, in crop causing impaction, emaciation, debility ; after 5 to 10 days impaction, and death in two days; lives also in ingesta in intestines. Latter demands vermifuges. *Spiroptera Uncinata* in gullet, crop, and small intestines; ducks, geese. Causes inordinate appetite, dysphagia, dulness, drooping, ruffled feathers, hurried breathing. *Tropisurus Inflatus* : Keel-like tail in male; in submucous cysts of gullet and proventriculus; duck, fatal inflammation.

The œsophagus may be the seat of a number of parasites most of which are habitually found in the stomach, and which do not as a rule cause serious trouble. Under given conditions, however, of special weakness or susceptibility on the part of the host, or multiplicity of the parasites these conditions are reversed, and a fatal parasitism may ensue. *Œstrus.* The larvæ of at least two œstri (gastrophilus equi and gastrophilus hæmorrhoidalis) are found in the gullet of solipeds and in a case, already quoted, the present writer found the presence of these parasites above the cardia, associated with local spasm and obstruction, and a fatal impaction with ingesta of the whole length of the viscus up to the pharynx.

Cooper Curtice has also found the larvæ of the œstrus (hypoderma) bovis in its earlier stages of development, in the walls of the gullet, migrating as he claims to its subcutaneous winter home.

Mesogonimus Pellucidum. Body flattened, reddish, transparent, 9 mm. long, 5 mm. broad. Has a terminal oral sucker, and a sessile ventral sucker in front of the genital pores. The body is narrowed in front, and spinous in its broad posterior half, *Habitat* in the gullet of the fowl.

Cephalogonimus Galli; having its genital openings one on each side and slightly anterior to the ventral sucker has also been found in the fowl's gullet.

Spiroptera. These worms are found in the epithelium of the mucosa of the gullet in horses (**S. Microstoma**), dogs (**S. Sanguinolenta**), oxen, sheep and goat (**S. Scutata**). The tumors caused by the spiroptera in horse or dog may attain to the

size of a hazel-nut, and in dogs have been known to interfere with deglutition, cause vomiting, and induce septic inflammation. (Brückmüller, Johne, Manson). The host may even die from inanition. Each tumor has a central orifice and when squeezed furnishes a purulent discharge in which the worms are found. In one colt of which the author was cognizant, the mucosa was abraded in patches for several inches above the cardia, and the spiroptera secreted under the remaining shreds. The colt had died of inanition.

The **Spiroptera Scutata** (**Gongylonema scutata**, Molin) found by Müller in the epithelium of a horse's gullet, is quite common in the mucosa of the thoracic portion of that organ in cattle, sheep and goats. The male is 1 to 1⅔ inch, female 2½ to 3⅓ inches long. Its presence is betrayed by a yellow longitudinal line in which the worm is found folded upon itself in a sinuous or zigzag manner like the wrinkles of a fibre of Merino wool. The yellow line may extend to an inch in length, while the worm, with its wrinkles effaced, may be from one to three inches. The smaller *spiroptera scutata* of the pig, named **gongylonema pulchra** by Molin because of the beautiful arrangement of its cutaneous papillæ is found also in the mucosa of the tongue and pharynx (Korzil). So far they have not been shown to be injurious to any of the hosts.

Trichosoma Contortum *in ducks.* The twisted hair-bodied worms, from ½ to 1 inch in length infest the *crop* of many birds and according to Railliet and Lucet, cause ingluvial indigestion (impaction of the crop). In an epizootic of this kind in Pekin ducks they found as many as thirty worms in one host imbedded in the mucosa of the cervical part of the œsophagus, their presence being betrayed by yellow lines, and extreme attenuation and inertia of the walls. The symptoms are progressive emaciation and weakness for five to ten days when impaction of the gullet and crop follows, and death enues in two days more. As the same worms are found free in the intestines it is supposed that this is only a temporary habitat. They cannot be reached by anthelmintics, but by the use of these a source of their supply in the intestinal canal may be cut off and a measure of prophylaxis ensured.

Spiroptera of the Duck **S Uncinata** This is a small

worm (male ⅓ inch, female ⅔ inch) which was found in large numbers in the gullet and crop as well as the small intestines of ducks and geese, inducing active inflammation and death. The only symptoms noticed were inordinate appetite, followed by dysphagia, dulness, drooping, ruffled feathers, and hurried breathing (Zurn).

Tropisurus of the Duck. T. Inflatus, and T. Fissisipinus. These are named because of the keel-like curvature of the tail of the male. They have been found in submucus cysts in the gullet and proventriculus of the domestic duck and may cause fatal inflammation (Zurn).

GASTRIC PARASITES IN THE HORSE. ROUND WORMS.

Round Worms: Spiroptera Megastoma: Mouth large with four horny papillæ in pairs; 2 to 6 lines, linear ova, viviparous. Lesions: Worm in galleries in mucosa, left sac; hazelnut to hen's egg, opening into stomach; Sometimes in œsophagus. *S. Microstoma:* Five lines to one inch; smaller mouth with two papillæ, viviparous; free in gastric contents, head in mucous gland duct, ulcers. *Symptoms:* Indigestion. Treatment: Benzine, phenol, carbon bisulphide. *Strongylus Axei:* Galleries in ass's stomach. *Strongylus Tenuissimus:* In gastric mucosa of horse. Larvæ of œstrus

Spiroptera. This genus is characterized by the fact that the caudal extremity of the male is spiral and furnished with membranous expansions or wings as clasping organs for the female. They are found mainly in the stomach or gastric mucosa of vertebrates. They are cylindroid, attenuated at both ends or merely in front; head nude or furnished with papillæ; mouth round with or without a pharyngeal cavity; œsophagus long, cylindroid; intestine slightly sinuous. Male has two spicula of different sizes. Female has tail straight, conical; two ovaries; genital orifice above or below the termination of the œsophagus. Oviparous; rarely viviparous.

Spiroptera Megastoma. Body white, cylindroid and equally attenuated at both ends. Head narrower than the body and separated from it by a constriction or neck, mouth large with four horny papillæ in pairs, the two vertical ones the larger. Funnel-shaped pharynx. Skin striated. Male 2 to 2½ lines in

length. Female 5 to 6 lines in length and ¼ line thick. Genital orifice in front of median part of the body. Ova almost linear with the embryo folded double. Viviparous.

Lesions. These worms burrow, hollowing out galleries and passages between the mucosa and muscular coat, and determine the formation of tumors varying in size from a hazel nut to a hen's egg. The galleries communicate with the stomach by small orifices varying in number from one to five or six. The worms are found in the galleries and may be pressed out by squeezing the tumor. Sometimes the contents consolidate giving the tumor a feeling of great firmness. In some instances there are found debris of the worms and purulent contents.

Pathogenesis. These are generally held to be harmless even when present in large numbers. This is hardly compatible with the extensive changes observed in the gastric mucosa, and more probably they cause impaired digestion, the true cause of which cannot be diagnosed. Railliet justly observes that the formation of tumors in or near the pylorous may hinder the passage of ingesta.

Spiroptera Microstoma. This is larger than the megastoma the male being 5 to 7 lines in length, and the female 1 inch. It lacks the cervical constriction, and has only two oral papillæ. It is viviparous.

This worm is found free in the liquid contents of the stomach, and just after death when still warm the fluid shows undulatory or boiling motion from the active swimming movements of the parasite. When cold, they are still and are usually overlooked on account of their small size. When the contents are firm or fibrous they must be looked for with great care. The parasite is often found with its head engaged in one of the mucous glands of the right sac, and in other cases its presence has been associated with extensive ulcers of the mucosa in this sac.

Pathogenesis and Symptoms. Apart from the lesions found postmortem, no characteristic symptom or result of these parasites has been observed. At the same time it is certain that such ulcerations as have been found must cause more or less gastric indigestion, and loss of condition, even though acute colic may be escaped.

Treatment of Spiroptera. This is essentially the same as for other parasites of the digestive organs. As the symptoms can not be distinguished from those of bots, it is well that the same agents (benzine, bisulphide of carbon, carbolic acid) are appropriate in both cases.

Strongylus Axei. This was found once in tumors of the gastric mucosa of an ass at the Royal Veterinary College London. It is a filiform worm with nude mouth and enlarging gradually, posteriorly. The male is 2½ lines in length and the female 3 lines. There were three unequal spicula. No pathogenesis was noticed.

Strongylus Tenuissimus. This worm was found by Mazzanti in the gastric mucosa of an old horse. The mouth is nude, with four papillæ behind it. The body increases from the head back. Male about 1 line in length, the female 1½ line. Bilobed caudal membrane ; 2 spicula. Vulva toward the posterior sixth of the body. Ova, eggshaped. No pathogenesis observed.

Œstridæ. The larvæ of the different forms of œstrus hibernating in the horse's stomach are among the most important parasites of the animal. They are treated elsewhere in connection with *Diptera* attacking the skin.

GASTRIC PARASITES OF RUMINANTS. PARASITES OF THE ABOMASUM.

Amphistoma conicum (cervi). Gastric strongyli of cattle very injurious. Characters : *Strongylus Contortus :* White or red, intestines shine through skin, two recurved papillæ on front part of body, tail pointed ; length 5 to 13 lines ; ovoviviparous ; ova elliptical. *Hosts* : Sheep, goat, argali, chamois, ox ; Europe and America ; blood-sucker ; oviducts give twisted aspect ; have several moultings in impure water out of the body ; cause plague in lambs and yearlings, less in aged. Worms attached to mucosa by mouth ; contents of stomach often bloody, tissues anæmic. *Symptoms* of pernicious anæmia, emaciation, flat wool, paper skin, dulness, inappetence, thirst, tympanies, black diarrhœa, embryos in fæces, in damp, infested pastures, in spring and summer, with lung worms. *Prevention :* Avoid infested pastures and streams, especially for young, infested new sheep, old, overstocked sheep pastures, dewy morning pastures, after rains ; salt in water ; rotation of crops. *Treatment* : Volatile oils ; arsenious acid. *Str. Filicollis* : Narrow-necked strongyle ; mouth small, circular, nude, alæ laterally on head, gullet club-shaped ; 4 to 9 lines ; ova elliptical.

Hosts: Sheep, goat in duodenum or stomach, head sunk in mucosa. Equally injurious as contortus. *Str. Ostertagi*: Brownish yellow, narrow towards ends, mouth nude, gullet club-shaped, membraneous fold over vulva, 3 to 6 lines long, free in stomach or encysted in mucosa; nodules with orifices *Hosts:* Ox, common in Berlin, Texas, etc. *Symptoms:* Anæmia, pallor of mucosæ, emaciation, dropsies, irritable bowels, mucous stools, ova in fæces. *Treatment* as for contortus. *Prevention:* Avoid infested pastures, waters, and animals; put pastures under rotation of crops. *Str. Vicarius:* Smaller than Ostertagi; lacks the membraneous fold over the vulva. *Host:* Sheep in Southern States. Produces anæmia, emaciation and unthrift. *Treatment* as for Ostertagi. O. Ostertagia. O. Circumcincta. O. Trifurcata. O. Marshalli. O. Occidentalis. Cooperia Curticei. C. Punctata. C. Onchophora. C. Pectinata.

ROUND WORMS.

Amphistoma Conicum (Cervi). Conical Fluke. This is a small conical fluke, about the length of an apple seed (10 mm. long, 2 mm. thick) and when freshly collected usually of a bright red color from contained blood. The oral sucker is terminal at the narrow cephalic end, while the ventral sucker lies centrally close to the caudal border. The two cæca are devoid of ramifications and extend into the caudal part of the body. In a direction from head to tail are found the uterus and genital pore just behind the bifurcation of the Cæca, followed in turn by the lobed testicle and ovary.

Habitat. They are found attached by the oral sucker to the mucosa of the rumen of *cattle* and *sheep* especially in the vicinity of the demi-canal. They do not survive in man.

Geographical Distribution. Europe, Asia, Africa, Australia, North and South America. Specimens have been collected in Canada and thirty-five years ago I found many of these flukes in a cow brought to Ithaca, N. Y., from Syracuse. Like other trematodes they propagate readily in damp lands where the water is fresh.

Evolution. Looss found the ova passed in the manure. In 12 to 14 days (above 72° F.) the egg hatched out a long narrow ciliated micracidium which swims free in the water and enters the viceral cavity of a snail (Physa alexandrina and P. micropleura) where it forms a sporocyst. This develops in fifteen days a generation of rediæ and a second or even a third generation may be produced, the last forming a generation of Cercaria

pigmentata which burst through the integment of the snail and swim freely in the water. The cercaria is 0.5 mm. long by 0.33 mm. broad with a navatory tail of 0.9 mm. They encyst themselves on plants and are taken in by the mammalian host in devouring these. Evolution takes about two months.

Symptoms. These are usually obscure and overlooked, the general health remaining good. When present in large numbers however the amount of blood extracted must in itself be harmful, and the little papillæ formed at the points of suction show that, in spite of the thick and insensible layer of epithelium in the rumen, abnormal vascularity and disorder ensue. In badly infested localities cows and to a less extent steers and heifers waste in flesh and numerous deaths occur. The round ovum can be detected in the fæces by the microscope after sedimentation.

Treatment is the same as for other flukes or tapeworms.

Three species of strongyli have been found in the stomach of ruminants, all of which are seriously pathogenic, so that the lesions caused by them might appropriately be included among pestilential diseases :

Genus : **Strongylus**. Among the characters of the genus are long, cylindroid body, generally narrowed toward the head ; head small, nude or with lateral membraneous alæ ; mouth small, round or triangular, nude or papillated ; œsophagus elongated. Male with caudal clasping membrane ; one or two spicula. Female with conical, obtuse or pointed tail ; one or two ovaries ; genital orifice behind the middle of the body, sometimes close to the anus.

Strongylus Contortus. Hæmonchus contortus (Twisted). Its body is red or white from ingestion of blood or abstinence, and narrowed toward the extremities. Two papillæ, curved backward, are on the sides near the anterior extremity. Male 5 to 8 lines in length, with bilobed caudal membrane. Female 8 to 13 lines ; tail pointed ; vulva toward the posterior fifth of the body, covered by a tongue-like process directed backward. Ova elliptical. Ovoviviparous.

Biology. This parasite is common in the abomasum of sheep, goat, argali and chamois (less so in cattle) in Europe and America. In its adult form it lives by sucking blood and thereby acquire

a brown color, modified by the white oviducts which are wound around the alimentary canal, giving its peculiar twisted appearance.

Leuckart traced the development of the embryos in impure water through several moultings, after which they were capable of reaching maturity in the stomach of the ruminant. In 14 days with a temperature of 60° F. moulting is completed, and the embryo, ensheathed in the latest unshed cuticle, is viable in the stomach of a suitable host. In the absence of such a host, it may survive in an ensheathed, torpid condition for an indefinite time in water, earth or manure. Though dry they will live for thirty-five days. Baillet failed to develop them in pure water. Manifestly they live out of the body in their immature condition in foul, stagnant water and damp soils.

Lesions. Pathogenesis. In infested districts the strongylosis rises to the importance of a plague, and renders sheep farming unprofitable. It is most severe in the lambs and yearlings, though no age is exempt, and is very fatal. The most remarkable *post-mortem* phenomenon is the presence of myriads of the worms fastened to the mucosa by their mouths, and in some cases virtually hiding portions from view. The mucosa is usually pale but may be bloody or ulcerated, and the contents sanguinolent. The abomasum is usually dilated. The contents of the large intestine are liquid, and the wool of the tail and hips are usually stained with the black feculent discharges.

Other worms are usually present in large numbers in the stomach and intestines and especially in the lungs, so that the helminthiasis is a complicated one.

One of the prominent features is the anæmic state of the blood. There is an excess of water and a deficiency of red globules, with many peculiar cells larger than the normal red globules, and distorted—scutiform, pyriform or claviform. These may be the red globules distorted by the dilute condition of the blood plasma.

Symptoms. These are those of a pernicious anæmia, marked by a gradual loss of condition, unhealthy wool, pale mucosæ and skin, disappearance of the subcutaneous fat (paperskin), dulness, langor, impaired or capricious appetite, thirst, tympanies and diarrhœa with black discharges, fouling the tail and hips. Worms are rarely seen in the fæces, yet a close search may discover the

embryos. History and environment will, however, contribute to a sound diagnosis, the victims are largely lambs and yearlings, the pastures have a reputation for fatality, and contain stagnant water or wet portions, the outbreaks take place mainly in spring and summer, and there is often coexistent trouble from pulmonary helminthiasis, the parasites of which have a similar life history out of the body.

Prevention. This will consist mainly in the avoidance, for pasturage for young sheep, of lands known to be infested, of lands through which flow streams coming through infested pastures, of breeding sheep that are from flocks harboring the parasite, of pastures that have been overstocked with sheep earlier in the season, of pastures wet with morning dew or rains, of pasture on wet ground or in wet seasons when the grasses are easily torn up by the roots. A free use of salt is also important as proving destructive to the young worms. A rich and abundant diet is also important. A rotation of cultivated crops and the exclusion of sheep and cattle from the field, for two years, will render land safe. Keep ewes and lambs in a barn yard till weaning time, sweep the yard daily, give noninfested food and water, and finally treat the lambs with vermifuges and wean, turning them out alone on a freshly-sodded pasture free from all possible drainage from other sheep pastures or where sheep or cattle manure has been placed. Or move ewes and lambs to a clean pasture every 15 or 30 days, till lambs are weaned, giving vermifuges each time.

Treatment. Chabert's empyreumatic oil, a coffee cup full daily; oil of turpentine, 1 part in 16 parts of milk—dose, 2 to 4 ozs., to be repeated if necessary in three or four days. Common salt, 3 lbs., powdered ginger and saltpeter, of each ½ lb., warm water 3 gallons, when cold add 24 ozs. oil of turpentine—dose, 2 ozs. for a lamb of four to six months; picrate of potash, dose for lamb, 4 grains, for a sheep, 20 grs.; tartar emetic 5 to 10 grs. in water; kamala, ½ to 1 dr. daily. Coal tar creosote 1:100: Dose, 4 months lamb, 2–4 ozs.; yearling, 3–5 ozs.; 3 to 8 mo. calf, 5–10 ozs.; steer, 1 quart (Stiles). Give from bottle; standing, the nose slightly above the level of the eye. Benzine, gasoline and thymol. Such are the usual remedies, but in the author's experience, these and the much advertised worm powders are usually ineffective. What is wanted is an agent which will pass through

the three first stomachs without solution and absorption, yet which will act as a vermicide when dissolved in small amount. This is found in arsenious acid which may be given in combination with other tonics. Arsenious acid 1 dr., sulphate of iron 5 drs., powdered nux vomica 2 drs,, powdered areca nut 2 ozs., common salt 4 ozs., mix, divide into 30 powders and give one daily. This has given me abundant success. Green tobacco 1 oz., or dry tobacco ½ oz. to sheep is effective. May be safely fed from a trough without restriction as to quantity.

Strongylus (Nematodirus) Filicollis. Body greatly narrowed in its anterior part; mouth small, circular, nude; a membrane projects on each side of the head; œsophagus dilated posteriorly; intestine slightly sinuous. Male 4½ to 5 lines in length, extremely filiform, tail with two large membraneous alæ and two spicula. Female 8 to 9 lines in length, very attenuated in front, tail pointed, two ovaries, one in front of the other, vulva behind the middle of the body. Ova elliptical.

This parasite is mainly found in the duodenum of sheep and goat, and sometimes in the abomasum in company with the strongylus contortus. It has the same blood-sucking habits, and if present in equal numbers must be quite as injurious.

Ostertagia ostertagi. Strongylus Convolutus, S. Gracilis. Body brownish yellow, attenuated toward each end; mouth small, round, nude; œsophagus short, thick, ending in a slight bulbous enlargement; .35 mm. behind the head, two barb-like papillæ directed backward. *Male* 3 to 9 mm., *female*, 4 to 12 mm. long. Male with caudal bursa obscurely lobed, supported by four rays on each side, the central pair bifid, and two supplementary rays turned upward. Two spicula. *Female* with vulva in the posterior tenth of the body, depressed and with a bell shaped membranous projection. Uterus double. Ripe ova, ovoid, forming a single chain in the ovarium and oviduct.

Habitat. In the Abomasum (mostly in mucosa) of sheep, goats, cattle and other ruminants.

This has been found by Ostertag in the abomasum in 90 per cent. of the cattle slaughtered in the Berlin abattoirs. It was not found in prime animals, but only in those in poor condition. Stiles has found it in American cattle and sheep. Though sometimes found free in the contents of the stomach, the female is

usually encysted in the mucosa so as to form minute, pea-like nodules, each having a small opening through which the worm passes. Many of the nodules are extremely superficial, so that they are readily ruptured under the pressure of the finger or of a knife blade and the tiny worms escaping, float on the surface. Often a portion of the parasite only projects, the remainder being still embedded in the nodule.

In an investigation made in Victoria, DeWitt and Gonzales counties, Texas, Dr. Ch. Wardwell Stiles found these parasites in every bovine animal, old or young, examined *post-mortem*, and in many cases microscopic sections of the mucosa "reminded one of a very heavy infection of muscular trichinosis in man, hogs or rats." The walls of the stomach were œdematous and greatly thickened, often from "half an inch to an inch and a half in thickness and appear like a mass of rubber that has been in zylene for a long time." The common experience was that it was not possible to put flesh on the affected animals by any kind of feeding, and the sufferers showed the general anæmic and dropsical appearance of animals suffering from blood-sucking nematode worms.

As customary in verminous invasions, the Ostertagia Ostertagi was not found alone, but usually associated with other parasites, the propagation of which is favored by the same conditions of damp or wet soil, a warm climate, close aggregation of a large number of animals, and the use of common feeding and watering troughs and pastures. Of other varieties of worms present in these Texas cases the following were especially common: Strongylus Micrurus, Strongylus Contortus, Uncinaria Radiata, Uncinaria Cernua, Œsophagostoma Columbiana, Distoma Hepaticum and Distoma Lanceolatum. Yet such was the degree of injury done to the mucosa of the abomasum by the S. Ostertagi that Stiles is constrained to say: "Although the worm is small I cannot escape the conclusion that it was the chief factor in the disease found among the cattle."

Symptoms. When at all numerous these bloodsuckers reduce the blood, health, vigor and condition, the ill effects being most apparent in the young animals. Anæmia with pallor of the visible mucous membranes and skin, a dry unthrifty aspect of the hair, excess of dandruff, clinging of the skin to the structures

beneath, lack of subcutaneous fat and of mellowness to touch, sometimes dropsical effusions in dependent parts, as beneath the jaws, throat, or sternum, shrunken muscles, and some irregularity of the bowels with muous-covered stools indicating gastric and it may be intestinal catarrh. The mucus might be examined for the ova of the worms. But in any case, if an animal from an unthrifty herd shows this verminous disease of the stomach on *post-mortem* examination, the remainder of the herd may be treated for the gastric parasites.

Treatment. In Stiles' hands no medication succeeded. The hidden worm, encysted in the nodules of the musosa was not effectively reached by any medicine introduced into the stomach. Nevertheless the treatment advised for S. Contortus might be resorted to in the hope of destroying the free worms and those that may protrude their heads from the galleries.

Prevention should be sought along the lines set down for the destruction of the eggs and young worms during their stage of existence outside the bovine host, and by the constant access to salt which is destructive to the embryos as they are taken into the stomach.

Ostertagia trifurcata. Smaller than the O. Ostertagi, and distinguished from it by the relatively shorter spicula (150 to 180μ), and by their trifid termination in one larger blunt branch and two lateral smaller and more sharply pointed branches. Female not identified.

Habitat. In chambers in the mucosa of the abomasum in sheep and goats in the United States, (especially noted in the Gulf States).

O. Circumcincta. Usually accompanies the trifurcata and ostertagi. It is somewhat larger than the trifurcata, and distinguished from it by the greater length of the spicula (280 to 320μ) and their *bifid*, instead of *trifid*, termination.

Habitat. The same as in the two preceeding forms.

O. Marshalli. The *male* has a very conspicious bursa (550 to 690μ when spread out), supported by a long, slender dorsal ray (280 to 400μ long) bifurcated 200 to 280μ from its origin. The accessory dorsal bursal membrane is very prominent (65 to 75μ long, by 70μ wide). *Spiculum* single (250 to 280μ long), trifid in its terminal fourth, and slender throughout, but with

the lateral terminal processes especially delicate. The eggs are very large and ovoid (160 to 200μ long, by 75 to 100μ wide), and are furnished with a double shell, an outer thin and delicate and an inner thicker and firmer.

Habitat. Abomasum of sheep in Montana.

O. Occidentalis. Somewhat larger than O. Marshalli with which it is commonly found ; length of male 12 to 16 mm. The bursa also is more expanded (650 to 740μ wide). Spicula double (290 to 320μ long) and trifurcated in its posterior half. The female of this species has not been identified.

Habitat. Abomasum of sheep in Montana.

Strongylus Vicarius. This is a worm found by Stiles in the abomasum of sheep in the Gulf States, resembling the S. Ostertagi, but distinguished by its still smaller size and by the absence of the special covering for the vulva in the female. It produces similar results and is to be opposed by the same measures as the S. Ostertagi.

Trichostrongylus extenuatus (Raillet) **Strongylus gracilis** (McFadyean), (extenuatus made slender). This very delicate worm was first described from specimens collected from the fourth stomach of cattle in England. It has also been found in sheep, goats, cattle and other ruminants in the United States (Stiles).

Trichostrongylus Capricola. A small strongle found in the abomasum of goats and sheep in the United States. It is distinguished from the *T. instabilis*, which resembles it in size, by the remarkable thickness of the latero-ventral ray of the bursa in the male. The terminal lateral branches of the dorsal ray are nearly equal in length to the central branch or stem. The spicula are devoid of the barbs shown in *T. instabilis*.

Trichostrongylus instabilis. A strongle from the abomasum of goats, sheep and other ruminants; resembles the capricola in size and form, but is readily distinguished by the fact that the internal lateral ray of the bursa in the male is thicker than the other rays, whereas in the capricola the latero-ventral ray is the largest. The dorsal ray also differs in having the two terminal lateral branches much shorter than the stem, whereas in capricola all three terminal divisions of the dorsal ray are of the same length. Finally the spicula of the instabilis are characteristically barbed at the point.

Trichostrongylus proboluris and **T. vitrinus.** These are listed by Looss as infesting the abomasum of ruminants in Europe.

Prevention and Treatment. The *trichostrongles* and other burrowing and bloodsucking worms of the fourth stomach and duodenum prove very intractable to vermifuges and most writers acknowledge that they are almost beyond the reach of medicine. The liquid and volatile anthelmintics are so much diluted by the massive contents of the first three stomachs and so largely taken up into the circulation that they usually reach the abomasum and duodenum in too dilute a state to be effective. If given after a laxative diet with free access to water, and accompanied by a purgative they do relatively better. Again by a continued free administration of less soluble vermifuges (arsenic, tobacco, etc.,) which go through the first stomachs, in large part, in the solid form, and reach the abomasum in a continuous stream, success may often be accomplished. For sheep and lambs tobacco in its crude form, either green, or simply dried, is one of the most available agents. The sheep is strongly insusceptible to the narcosis, and may be allowed to eat the drug at will, from troughs in which it is kept fresh. After eating it for one or two days, they may leave it, when the troughs may be emptied and a fresh supply offered three or four days later. The treatment often fails because the tobacco is mixed with an equal amount of salt which proves an irritant to the water-abstemious sheep and an insufficient amount of the tobacco is eaten. Salt is best omitted, unless it be a mere sprinkling to act as a condiment and tempt the animal to eat more freely. It will stop eating when it has had enough and there is no risk of an overdose and hurtful results. Again the tobacco should be fed pure and not in the prepared forms in use for making snuff, cigars, cigarettes, or other forms of smoking tobacco.

To *prevent* the access of fresh embryo worms to the system the same watchful care must be taken as for other nematodes (see Strongylus Contortus). Drainage of swamps in pastures, avoidance of streams that drain other sheep pastures, of shallow wells, ponds and all other contaminated sources, the exclusion of infested ruminants, cultivating of sheep pastures, giving fresh seeded pasture yearly, especially to lambs, avoidance of overstocking, raising lambs in a bare lot, etc.

GASTRIC PARASITES OF SWINE.

Spiroptera Scutatum in buccal and pharyngeal mucosa. *Spiroptera Strongylina* : White, curved, round, nude mouth, alated ; tail spiral in male, pointed in female ; 4 to 8 lines long. Habitat : Submucous tumors of stomach, swine. *Gnathostoma Hispida* : Hooked plates around mouth. Habitat : Stomach of pig ; Russia, Austria ; burrows head in mucosa, with congestion and exudation. *Symptoms* : Indigestion, gastric catarrh, tympany, vomiting, emaciation, pallor, weakness. *Treatment* : Oil of turpentine, santonin, etc., tonics, generous feed. *Simondsia Paradoxa* : Narrow toward head, mouth has two papillæ, alated, 5 to 7 lines long ; uterus forms large rosette near tail. *Habitat* : Stomach, pig, female in gallery in mucosa, male free in stomach.

Spiroptera (Gongylonema) Scutatum, has been found by Korzil, in spiral form, in the buccal and pharyngeal epithelium, as well as free on the mucous surface. It appeared harmless.

Spiroptera Strongylina. Body white often bent in a semicircle ; mouth round, nude ; a narrow lateral wing on one side. Male 4⅓ to 6 lines long, tail spirally curved in 1½ turn, and with two broad unequal membranous alæ, six papillæ on each side, asymmetrically arranged, spicula long and thin. Female 6 to 8 lines long, body thin especially in front, tail pointed, vulva immediately in front of the anus.

Habitat. Found in submucous tumors of the stomach in pigs (2 out of 19 wild boars in Vienna), less frequently in domestic pigs. No pathogenesis has been traced to it.

Gnathostoma Hispida (gnathos, jaw, hispidus prickly). The anterior extremity is furnished with a formidable armament of twelve rows of chitinous plates with sharp backward curved hook at the summit of each. Male 1 inch in length. Female 1¼ inches.

Habitat and Lesions. This has been found in the stomach of swine in Vienna and Russia. It bores its head into the mucous membrane, fixing itself by its numerous hooks, and lives by sucking the blood. The point of attachment of the worm is shown externally by a small red or black spot on the serosa. Internally the mucosa is inflamed and between the folds the worms are found to be engaged by the head in the centre of congested mammiform swellings.

Symptoms. There is indigestion, and gastric catarrh, with tympany, occasional vomiting and other signs of irritation. The general symptoms are those of debility induced by the loss of blood, loss of condition, pallor of the mucous membranes and general weakness.

Treatment. Oil of turpentine, santonin or other vermifuge would seem to be indicated, associated with tonics and nourishing food.

Simondsia Paradoxa. Body cylindroid, and narrowed toward the cephalic end which has two narrow lateral alæ. Mouth with two prominent papillæ. Male 5⅓ lines long, a spiral tail and two long delicate spicula. Female about 7 lines in length, and toward the caudal end has a large rosette like body consisting of the uterus developed externally.

Habitat. Found by Simonds in the stomach of a German pig in the London Zoological Gardens. The male was free in the contents of the stomach, while the female occupied a cyst in the mucosa from which it protruded its head through a small opening into the gastric cavity.

From its habits it is probable that if present in large numbers it would give rise to gastric indigestion and inflammation.

GASTRIC PARASITES OF THE DOG.

Spiroptera Sanguinolenta: Blood-red, narrow toward ends, mouth large, round, œsophagus club-shaped, intestine straight, anus terminal, 1 to near 3 inches long, oviparous, eggs ovoid. *Habitat*: Hard submucous tumors of gullet, more rarely of stomach; dog, wolf; S. Europe, China, Brazil. Each gallery opens into gullet or stomach; may contain 20 worms; also in lung, aorta, and lymph glands. Larval form in eastern cockroach. *Symptoms*: Vomiting, emaciation, gastric catarrh, ravenous appetite, pulmonary, pleural, aortic or glandular disease. *Treatment*: Vermifuge.

Spiroptera Sanguinolenta. This parasite is remarkable for its blood red color from which its name is taken. Body cylindroid; narrowed toward the extremities; spirally twisted; head narrower than body; mouth large, round; œsophagus long, enlarging posteriorly; intestine straight; anus terminal. Male 1 to 1¾ inches long; tail spiral, with two lateral alæ, each sus-

tained by six papillæ ; two unequal spicula. Female 2 to 2¾ inches long ; tail slightly curved and blunt ; vulva about two lines behind the mouth. Eggs ovoid. Oviparous.

Habitat. In hard submucous tumors of the œsophagus and less frequently of the stomach in the dog, wolf and fox in Southern Europe, Tunis, Algeria, China and Brazil. The tumors vary in size from a hazel nut to a pigeon's egg, and have not exceeded three in any case. The worms live in the chambered interior, but can pass out through a common orifice into the œsophagean lumen or gastric cavity. From two to twenty worms have been met with in a single tumor. They have also been found in the lung, the aorta and the lymphatic glands.

Davaine holds that these worms enter œsophagean or gastric glands which become distended and sacculated by their presence. The orifice shows neither erosion nor ulceration.

Biology. Grassi has traced the life history of this spiroptera, having found it in the larval condition in the abdominal cavity of the eastern cockroach (Periplaneta Orientalis), which he fed to dogs, and fifteen days later found the worms embedded in the œsophagean mucosa. It would appear that the cock-roaches become infested from devouring the droppings of dogs, and that dogs in turn become infested by eating cock-roaches.

Symptoms. There may be vomiting, fits of spasmodic coughing, clonic phrenic spasms, and rapid loss of condition when the parasite exists in the œsophagus or cardia. Temperature may rise to 104°. Voracious appetite has been noticed in some cases of gastric spiroptera.

Gastric catarrh may also exist. There may be signs of pulmonary, pleural, aortic or glandular disease according to the location of the parasite.

Treatment. Has not been extensively attempted but would be essentially vermifuge. Oil of turpentine has succeeded in certain cases.

Œstrus equi larvæ have been found attached to the gastric mucosa of the dog. (Colin, Schliepe).

Ollulanus tricuspis .: ***Mature*** in chambers hollowed in gastric mucosa of cat and small rodents, and as *larva* in liver, lungs, pleura, diaphragm, or intestinal contents. Female has three hooks on tail. Length 1 mm., like larval trichina, but contains ova and embryos which distinguish it. Lesions: Isolated red nodules, or congested, ecchymotic, softened patches shedding epithelium, and catarrh; ovoviviparous. Embryos present in the ingesta and fæces, and even in bronchial mucus. Cysts in solid organs may each hold several asexual worms and cause fatal inflammation. *Treatment:* Vermifuges, destruction of rats and mice. *Parasites of cat's prey* accidentally swallowed.

Ollulanus Tricuspis (olla jar). This is a small round worm which passes through its sexually mature condition in the gastric mucosa of the cat and small rodents, and its larval state encysted in the internal organs (liver, lungs, pleura, diaphragm), or free in the intestinal contents of the same animals. It has accordingly been often mistaken for trichina. The name is derived from the three pointed processes on the caudal extremity of the female, which together with the presence in its oviducts of ova and two or three large sized embryos, at once distinguish it from the wandering or encysted trichina. Both sexes are further distinguished by the open, urn-shaped buccal capsule.

The mature female is 1 mm. in length; the male somewhat smaller. The larval trichina, for which alone it may be mistaken, is 0.8 to 1 mm. in length.

The *mature* ollulanus living in the substance of the mucosa produces effects corresponding to the number of worms. If few there may be minute red nodules only. If abundant there may be general or extensive congestion, ecchymosis and softening, with desquamation of the epithelium and catarrhal discharge. Beside the mature worms are found large embryos which have not yet migrated from their place of birth. The worm is ovoviviparous.

The *embryos* escape from the mucosa into the intestinal canal so that they are found in large numbers in the contents of the bowels and in the fæces. Others migrate inward and invade the diaphragm, liver, lungs, pleuræ, and the muscles generally in which they form cysts resembling those of the trichina, .15 to .20

mm. in length. These cysts have thick dense walls, and each contains one or several embryos rolled up on themselves. In the lungs they are embedded in minute areas of hepatization, and may be readily mistaken for miliary tubercles, and when very numerous, dangerous and fatal pneumonias may ensue. In bad cases the embryos may often be detected in the bronchial mucus.

As in the case of trichinæ, the encysting of the worm in the solid organs, puts an end to its migrations and limits development to the asexual stage. To reach maturity its host must be devoured by another appropriate host, in the gastric mucosa of which it may burrow and advance to its full development. The natural cycle of development would seem to be: first (*immature*) in the stomach, bowels and solid organs of the mouse and rat; and second (*mature*) in the stomach of the cat and immature in the bowels and solid organs of the cat which feeds on the infested rodent. The rodents may get infested from the manure of the suffering cat or from water that has washed embryos from it, and also from the fæces and flesh of each other (Leuckart).

Treatment must be mainly directed to the destruction and expulsion of the embryo worms that may be free in the intestinal tract, and for this the usual vermifuges and purgatives may be employed. The destruction of rats and mice will also go some way toward keeping cats free from invasion. Yet the cat may perhaps be reinfested from its own bowel dejections and that of its fellows, that may be suffering from the worm.

Other Parasites. Cats like dogs take in various parasites of their prey, which may be found alive in the stomach, but cannot be looked on as real parasites of the cat. This possibly explains the *physaloptera* found by Lutz in a cat in Brazil, as it does the *heterakis* found by Neumann. Both are parasites of fowls. Yet *Physaloptera Digitata* lives in the stomach of the puma (felis concolor) of Brazil.

PARASITE OF RABBIT'S STOMACH.

Strongylus Strigosus of the Stomach of the Rabbit. Body cylindroid, attenuated, blood red, with about 50 longitudinal lines from which it derives its name (striped strongle). Male 3½ to 7 lines in length, caudal membrane campaniliform,

two spicula with brush-like terminations. Female 4½ to 9 lines in length, vulva near the posterior tenth of the body.

Lesions. These have been found by thousands in the stomach of warren rabbits, sucking the blood and giving rise to a most destructive epizoötic marked chiefly by anæmia, emaciation and marasmus. They must be *treated* by vermifuges (areca nut), separation of infested, cleansing or changing of warrens and runs.

PARASITES IN THE STOMACHS OF BIRDS.

Dispharagus Spiralis and Nasutus. Nasutus has large papillæ on sides of mouth; constrictions in pharynx; 2 to 3 lines long; in wall of gizzard. hen and sparrow. *Symptoms:* Dulness, dejection, but good appetite. *Treatment:* Vermifuges. *Dispharagus Hamulosa* in tumors on gizzard of chicken. *Physalopterus Truncatus* in proventriculus of chicken; Brazil. *Tropisurus Inflatus* and *Trop. Fissispinus* in submucous cysts in proventriculus of duck. *Histrichis Tricolor*, with front of body spinous, and back, intestine and gullet three colors; in proventriculus. *Strongylus Nodularis*, with two buccal vesicular nodules and three teeth; in mucosa of proventriculus, gizzard and duodenum of goose. *Histrichis Pachycephalus* in nodules of the proventriculus, swan.

Dispharagus Spiralis. Found in the mucosa of the gullet, crop, proventriculus and gizzard of chickens. It is characterized by the spiral tail of the male, with membranous expansions. Male 7 mm., female 9 mm. long.

Dispharagus Nasutus of Chickens. (Large nosed). This parasite is named from the division of the pharynx in two cavities and from the nose-like projection forward of two papillæ on each side of the mouth in the female. The male is about two lines long, the female three lines, and both live in the wall of the gizzard of hen and sparrow.

Pathogenesis and Symptoms. Legros describes a deadly epizoötic caused by this parasite, which, present in myriads, burrowed the anterior part of the body or the whole in the wall of the gizzard and sucked the blood. The fowls were dull, dejected and emaciated, yet retained a voracious appetite to the last.

Diagnosis can hardly be made apart from a necropsy, but once recognized, the disease should be treated by one of the various vermifuges.

Dispharagus (Spiroptera) **Hamulosa** (small hook) was found by Natterer in small tumors on the surface of the gizzard of a fowl in Brazil. The male was 4½ lines in length, the female 10 to 12 lines. No evil effects are noted.

Trichosomum Contortum has been especially destructive to the young of Pekin ducks, burrowing under the mucosa of the cervical dilatation of the gullet, and causing attenuation, atony, impaction, inability to swallow, emaciation, dulness, pressure on the vagus, and asphyxia. The worms are also found free on the mucous surface. A wide range of birds suffer not only among the palmipeds, but also the Passeres, Grallatores, and Raptores. The male is 12 to 17 mm. long, by 7 to 9 μ broad; the female 31 to 38 mm. long, by 9 to 10 μ broad.

Dispharagus Uncinatus is also found in the gullet of the duck and goose in nodules in the mucosa.

These may be treated by vermifuges, but the chief object should be prevention, by pure water, poultry yards, and sound poultry.

Physalopterus Truncatus (cut off). So called because of its puffed up lips, each provided with three papillæ externally and teeth internally at the extremity. The male is about 12 lines in length and the female 16 lines. It has been found in Brazil in the proventriculus of a chicken. Pathogenic effects are not recorded.

Tropisurus Inflatus and **Tropisurus Fissispinus** are two species of parasites of the proventriculus of the duck, inhabiting submucous cysts and sometimes giving rise to fatal inflammations (Zurn). The female has a thick ovoid body. The male is thread-like, 15 to 18 times longer than it is thick, and with its tail turned downward like a keel.

Hystrichis Tricolor. So named because the anterior part of the body is studded with hooklets or prickles. The female, about 12 lines in length is white externally, with black intestine and red œsophagus, giving three colors to as many parts of the surface. It has been found with the hooked anterior part of the body buried in the walls of the proventriculus of the duck, so that it was impossible to extract it. It gives rise to irritation and inflammation.

Strongylus Nodularis. Body cylindroid, attenuated in

front, the mouth has laterally two vesiculous nodules, and in the pharynx are three teeth which can be projected externally. The male is 4½ to 5 lines long, the female 4½ to 9 lines in length. The vulva is over ½ line from the end of the tail. This is found in the tame goose in the mucous and muscular coats of the proventriculus, and duodenum.

Hystrichis Pachycephalus of the Swan (thick head). This gross and prickle headed parasite was found in nodules of the muscosa of the proventriculus of the swan.

INTESTINAL PARASITES AND MESSMATES, OF HORSES, ASSES AND MULES.

Infusoria. Globidium Leuckarti. Tænia Perfoliata: Large unarmed head, short, bread body; ova polyhedral; in small and large intestines; Germany, Russia, Scandinavia, France, United States. *Symptoms* of intestinal worms. *Treatment*, tæniacides. *T. Mamillana:* Unarmed head, suckers with crescentic opening, segments at first mere transverse lines, and at tail 2 to 3 mm. long by 4 to 6 mm. broad. In duodenum and ileum, solipeds; Germany, Scandinavia, France, America. *T. Plicata:* Unarmed head, cupped suckers; 6 to 30 inches. In small intestine and (rarely) stomach; soliped; Senegal, Tunis, France, Germany, America. *Symptoms* of intestinal worms, low condition, variable appetite, irregular bowels, indigestion, colic, etc.; passage of segments. *Treatment:* tæniacides. *Cysticercus Fistularis:* Tape-worm, larva in peritoneum, solipeds. France, Germany. Head armed; mature form unknown. *Amphistoma of Collins*, of *Stanley*, and of *Sonsini:* Conical or elliptical, red worm, two suckers, buccal and caudal; intestines, and nose, pharynx, gullet and stomach. India, Egypt, Senegal, Guadaloupe. Causes epizoötics, with sudden death, or indigestion, enteritis, anæmia, or emaciation. *Treatment:* As in distomatosis. *Ascaris Megalocephala:* Large head, trilabiate mouth, tapers to ends, 5 to 15 inches long, in small intestines (bile or pancreatic ducts). Cause colics, indigestions, watery diarrhœa, emaciation, anæmia, pot-belly, passage of worms or ova. *Treatment:* Tartar emetic, oil of turpentine, benzine, thymol, arsenic. *Prevention:* Pure water, clean mangers, salt. *Oxyuris Curvula:* In large intestine, curve in anterior part of body, one inch long; ova with button-like prolongation. Causes indigestion, ill-health, fur on anus, rubbing rump, passage of worms or eggs. *Treatment:* As for ascarides; quassia, etc., as enema. *Oxyuris Mastigodes:* Tail of female 3 or 4 inches; common. *Treat* as for curvula. *Sclerostoma Equinum; S. Tetracanthum:* Armed mouth like equinum, but with four large opposing teeth; 1½ to 2 inches; in large intestine; larvæ in cysts in mucosa, and in pea-like manure-pellets. Pathogenesis, symptoms and treat-

ment as in oxyuris. ***Filaria Papillosa:*** A silk-like thread worm, active movements, mouth with eight papillæ. In serosa, eye, connective tissue; unthrift, dropsy of sheath, scrotum, limbs; no effective treatment. *Anguillula; Diptera Larvæ; Œstrus*; *Helophilus Pendulinus.*

INFUSORIA IN LARGE INTESTINE.

Entodinium Bipalmatum. Conical, with mouth at base. Length, 600μ.

E. Valvatum. Rectangular. Ciliary crown at mouth; two posterior. Length, 214μ.

Diplodinium Unicinatum. Ciliary crown at anus. Length, 900μ.

D. Unifasciatum. Two anterior peripharyngeal ciliary crowns; one posterior. Length, 230μ.

Spirodinium Equi. Spiral ciliary crown anterior to posterior ends. Length 230μ.

Triadinium Caudatum. Three ciliary crowns, one anterior, two lateral. Length 300μ.

These are non-pathogenic and grow in the vegetable infusion as they do out of the body in similar mixtures.

Organism of Indeterminate Species.

Globidium Leuckarti. Max Flesch found in the villi of the small intestine of a horse, an elliptical or spherical organism 80μ long by 70μ broad, but encreasing in certain cases to 160μ or even 340μ in length. It contained many refrangent spherical bodies, generally distributed or enveloping a central protoplasm, and sometimes a pyriform body. The most plausible suggestion is that it belongs to the sarcosporidia.

This parasite was mildly pathogenic, being surrounded by slight inflammation of the intestinal mucosa.

CESTOIDS. TÆNIÆ.

Anoplocephala (Tænia) Perfoliata. (Anoplos shield; unarmed). Head very large, tetragonal, with cup-shaped suckers, but without proboscis or hooklets, segments very short and broad, encreasing in breadth to 2 mm. in the ninth, narrowed at the anterior border, and overlapping the next segment behind.

First six or eight segments are non-sexual, from this to the 19th they are male, the three next are hermaphrodite, and the terminal ones essentially female. Total length 26 to 28 mm. (may reach 80 mm., Rudolphi). *Ova* polyhedral by packing together and very active embryo. *Larva* unknown. *Habitat:* Cæcum and small intestine, rarely the colon. Common in Germany, Russia, Scandinavia, South of France and some portions of the United States.

Pathogenesis. Causes the ordinary symptoms of intestinal worms. Megnin and Perroncito have described saccules of the intestines filled with these tæniæ, and rupture of such pouches causing peritonitis, colics and death.

Anoplocephala (Tænia) Mamillana. Mammiform tape-worm. Length 1 to 5 cm. Head tetragonal, smaller than in *perfoliata*, suckers opening in a hemispherical longitudinal slit, no proboscis nor hooklets. Segments at first hemispherical clasping the head, then widening and lengthening to finally 4 to 6 mm. broad, by 2 to 3 mm. long, *Ova* oblong 88μ in length. *Larva* unknown.

Habitat. The duodenum and ileum, exceptionally the stomach, of solipeds. It has been found in Germany (Blumberg, Greve, Hering), Scandinavia (Krabbe), France (Cadeac), and America. It is less common than T. Perfoliata.

Anoplocephala (Tænia) Plicata. Folded Tape-worm. Head very large, tetragonal, but slightly flattened (2 mm.) but without proboscis or hooklets. Suckers cupped and directed forward. Length may be 6 to 30 inches (Davaine, Railliet, Cadeac). Maximum breadth at the middle of the body 6 to 20 mm. Length of segment gradually encreases to 2 mm. at the tail. *Ova* round or polyhedral. *Larva* unknown.

Habitat. In the small intestine and (rarely) in the stomach. It is more rare than the *perfoliata* and *mamillana*. It has been found in the ass in great numbers in Senegal (Sarciron), in the mule at Gabes, Tunis, (Beugnot), in France (Hendrickx, Blanc) in Germany (Hering).

Pathogenesis. It is generally held to be harmless, but the cases of Sarciron and Hendrickx show that when present in large numbers it may cause indigestion and even enteritis.

Symptoms of tape-worms. These are those of intestinal

worms in general, unthrift, low condition, variable appetite, irregular bowels, indigestion, colics, enteritis, anæmia, pot-belly, skin eruptions, and above all the passage of ripe segments of the worms. These are however, only discovered with difficulty.

Treatment. As for tænia in other animals and will be described later.

Cysticercus Fistularis (pipe-like bladder-worm). This is the larva or cyst of an unknown tape-worm. It has been found on rare occasions in the peritoneum of the horse. It has a length of 1.5 cm., cylindroid, very thin, and with a cylindroid caudal vesicle. Total length three to four inches. Head tetragonal and furnished with a double row of hooklets. It has been found in France (Chabert) and Germany (Reckleben).

TREMATODES OF THE SOLIPED.

Three trematodes have been found in the intestines of solipeds, the *Amphistoma Collinsi*, the *Amphistoma Collinsi varietas Stanleyi* and the *Gastrodiscus Sonsinoi.*

Amphistoma of Collins. These are thick short worms of a brick red color, having an anterior sucker surrounding the mouth and a posterior sucker at the caudal end. In Hindostan they are known as *masuri*, and multiply by thousands in the large intestines, giving rise to indigestions and enteritis. The illness may be recognized by the presence of the worms or their eggs in the manure. As they must be developed through the characteristic alternate generations of trematoids (see distomatosis) they may be guarded against by avoiding infested water and pastures, or destroyed by the liberal use of salt or vermifuges.

Stanleyi variety of the Amphistoma of Collins is pronounced by Cobbold to be essentially different.

Gastrodiscus of Sonsini (gaster belly, diskos plate). This parasite has a red flattened body in the form of a short ellipsis. The back is smooth, the venter covered with about 200 papillary suckers. The anterior end bears a conical papilla, 2 mm. in length on the free end of which is the buccal sucker. The posterior sucker is terminal and fastens the parasite to the mucosa. The body is about 12 mm. in length, and 10 to 11 mm. in breadth.

It was discovered by Sonsini at Zagazig, near Suez, Egypt, in horses dying of an enzoötic, and has since been found in asses in Senegal (Sarciron), and in mules in Guadaloupe (Guyot, Cousin) and India (Giles). Collin has also found it in a zebra.

Habitats. In horses it was found in the small and large intestines in large numbers. In mules it was present in thousands in pharynx, œsophagus, stomach, intestines and nasal fossæ.

Pathogenesis. Some of the victims died suddenly and others only after a long period of anæmia and ill health.

Treatment. As it is taken in as cercaria this may be prevented by giving due attention to the water and food (see distomatosis). Otherwise it may be treated by salt and other vermifuges.

ROUND WORMS, (NEMATOIDS) OF SOLIPEDS.

Ascaris Megalocephala (*megalocephalos large head*). While ascarides are distinguished by their relatively large size, this species is larger than others. The *male* is 5 to 9 inches, and the *female* from 6 to 15 inches in length. It is further distinguished by its large head expanding at the end of a neck, and furnished with three papillary lips bearing teeth on their free margin. The *male* has its tail furnished with two lateral membranous alæ, and a great number of papillæ, which are in two rows behind the anus and in several rows more anteriorly, also two cylindroid, curved spicula. The *female* has its tail conoid and obtuse, anus nearly terminal and vulva toward the anterior fourth of the body. *Ova* are almost globular, and have great vitality, the contained embryos remaining alive for two years in water, dung, moist earth, or on glass slides. Hence they can remain in wells, ponds, and the dust of stables and yards to enter the system with the food and water.

Habitat. The small intestines of solipeds; very common and often in great abundance.

Pathogenesis. They often produce no visible symptoms in mature solipeds, but in the young, and if in great numbers in the old as well, they prove very injurious. At the Brussels Veterinary School more than 1800 were found in one horse, and the present writer has collected a gallon which were passed by one

subject under the use of vermifuges, and on another occasion has taken as many from the small intestines *post mortem*. They have been found to pass into the stomach (Neumann), the bileduct (Röll) and the pancreatic duct (Generali).

Colics, indigestions, slight muco-enteritis, and watery diarrhœa may be noted as among the local lesions and disorders caused by these worms. Gavard, Wirz and Zurn have cited cases, in which the worms seemed to have perforated the intestinal mucosa and escaped into the peritoneum. Hepatic and pancreatic disorder may follow the blocking of the biliary and pancreatic ducts. Apart from these conditions are the general symptoms of unthriftiness, emaciation, anæmia, rough coat, pot-belly, the presence of fur around the anus, the habit of passing a little liquid before defecation, or there may be watery diarrhœa and in exceptional cases nervous disorder. In one case tetanic symptoms set in but yielded promptly to vermifuges (Dieckerhoff). In another case paraplegia yielded to anthelmintics (Damitz). The conclusive symptom is the passage of the worms.

Treatment. This is much more effective than in the case of pin-worms, as the ascarides, living in the small intestines can be much more easily reached with medicine, and as they live mainly on the ingesta they consume and are killed by the vermifuge dissolved in these. Almost any vermifuge may be given, but tartar emetic 2 drs., given every morning, on an empty stomach, for six days, and followed on the seventh by a good purgative proves very effective. Oil of turpentine 2 ozs., in milk emulsion, or thymol or santonin 3 to 4 drs. may be given. Benzine in a dose of 1½ oz. is effective. Sulphate of iron 2 drs. and arsenious acid 10 grs., given every morning is often very effective though in obstinate cases the writer has had to double the dose of the latter agent. Vermifuge treatment is, however, of no avail unless the access of fresh ova through the food and water can be prevented. Water from deep wells, well protected by cement from surface drainage, and careful sweeping of the stables to clear away infested dust must be secured. Old pastures charged with the ova must be avoided, especially for young colts. Finally the general health and vigor must be sedulously looked after.

Oxyuris Curvula (*oxys pointed, oura tail*). The *curved oxyuris* is a very common parasite of the large intestine, constituting one

of the common *pin-worms* of horsemen. The curve described by the anterior part of the body has secured for this worm its specific name (Curvula) as its sharply pointed tail has the generic one (oxyuris). The *female* is 1 to 1¼ inch long, thick anteriorly, attenuated gradually to a fine point behind, and, as it were, cut off obliquely; head conical, mouth round or, if the 3 papillæ are projected—triangular, furnished with three horny bars and behind these with other folds beset with horny spikes. Vulva about 10 mm. from the mouth, and anus in the anterior thick portion of the body. *Male* is 9 to 12 mm. long, with obtuse caudal end, bearing several papillæ the last of which bears a well developed membranous clasping apparatus. Spiculum is single. *Ova* insymmetrically oval, with a button-like projecting operculum at one end.

Habitat. The cæcum, colon, and rectum of solipeds. It is very common and often very abundant. Eggs and embryos are found in masses under the mucosa and the young worms even in bloodvessels.

Pathogenesis. Though not nearly so injurious as the blood-sucking pin-worms (sclerostomata) yet the oxyuris when present in large numbers will greatly impair the general health, producing indigestions, colics, diarrhœas, general unthriftiness, anæmia, pot-belly, pruritus ani, and the presence of a grayish fur round the anus from the drying of mucus. Microbes are carried into the mucosa by the ovigerous female and into the blood by embryos, determining local and general infections. The passage of worms with the fæces serves to identify the true cause of these symptoms.

Treatment is essentially the same as for ascarides though the presence of the parasite in the large intestine only makes it more difficult to reach. Injections are often used to advantage (quassia infusion, benzine, naphthalin, etc).

Oxyuris Mastigodes (*mastix whip, eidos form*). The long-tailed oxyuris like the oxyuris curvula has its distinguishing features in the female. This consists in a prolongation of the tail to three or four inches long. The parasite is found in the fæces, or arrested in the anus, its long attenuated tail shrunken to a delicate filament of skin in longitudinal folds as if it had just been delivered of its contingent of eggs. It has been noticed

by Nitsch and Friedberger in Germany, and Blaise and Condamine in Algiers and France. It is quite common in New York. The general characters closely resemble those of the oxyuris curvula, so that Railliet holds it to be but a variation, shown in a dimorphism of the females.

The *habitat*, *symptoms* and *treatment* are essentially the same as for the oxyuris curvula.

Sclerostoma equinum, Müller. (*Strongylus Armatus*, Rud., *Palisade worm.*) *Mature form.* Color gray, or brown shaded by red in marked contrast with the milk-white oxyuris which it resembles in size. The mouth is habitually open, round, and armed with three concentric chitinous rings of which the *outer* presents six short papillæ arranged symmetrically in pairs; the *intermediate* has a series of rounded tooth-like processes; the *inner* a circle of fine, close-set and very sharply pointed, lancet-like teeth for penetrating the mucosa and drawing blood. *Male* ¾ to 1¼ inch long, with caudal, clasping membrane in two main, lateral lobes, with a smaller central lobe between, the whole being supported by three pairs of rays—the central being trifurcate, the outer quadrifurcate and the intermediate undivided; two delicate spicula. *Female* ¾ to 2 inches long, tapering slightly toward the head, and much more considerably toward the tail which ends in a blunt or rounded point in marked contrast with the sharp, pointed extremity of the oxyuris. The vulva is in the posterior half of the body. *Oviparous.* *Eggs* ovoid with a slightly raised ring around the median part.

Habitat. In the cæcum, colon and rectum of solipeds, usually firmly attached by the mouth to the mucosa, in which its sharp teeth, and even its head, are sunk abstracting the blood.

Sexually Immature forms. From the ovum there is hatched, in the intestines, or outside in water or mud, a rhabditiform (rod shaped) embryo, and this taken into the stomach and bowels develops through the larval forms into the sexually mature worm.

The *rhabditiform embryos* may be hatched out in the intestines, and are finally expelled, when they follow the course of those hatched outside. The ova, expelled in manure, hatch out in that medium, or in water or damp earth. The embryo has a length of 2 to 3 mm., thick at the cephalic extremity, and with a delicate filiform tail. It may here moult and grow to 1 mm. to 1.5 mm.

long, and continue for months this size without further development (Baillet).

Colin believed that the ova, deposited in the ducts of mucous glands and in perforations made by the teeth of the parent worm, hatched in this situation and that the embryo at once encysted itself in the mucosa and submucosa. Leuckart imagined an intermediate host outside the body of the soliped, which prepared the embryo for a new career in the equine host. No demonstration of the truth of either view has been made.

Larval Stage. When the embryo is taken in by a soliped in food or water, it developes in the intestines, passing through several moultings, and assuming the form of an *asexual larva.* Reaching the intestine these larval sclerostomes bore their way into the mucosa in which they encyst themselves for an indefinite period. In traversing the tissues and vasa vasorum they induce capillary embolism, hæmorrhagic infarction, and exudation into the connective tissue with considerable softening. Through this softened tissue the larvæ, having attained a length of 8 to 10 mm., bore their way toward the lumen of the blood vessel causing a steady advance in the exudation and softening. When this has reached the inner coat of the blood vessel the latter is raised into a vesicle containing the larva within it. A thrombus forms in the vessel in contact with the vesicle, and gelatinoid, fatty and mucoid degeneration pave the way for the entrance of the parasites. The softened walls yield to the internal pressure of the blood causing aneurisms, the walls of which tend to become thickened, fibroid and even calcic. Sometimes ulcers or even abscesses form, but usually the intima of the aneurism is found to be smooth and unbroken and the larval worms live in the worm canals or galleries excavated in the blood clot. In this habitat the larva may attain to a length of $\frac{1}{10}$ to 1 inch, but it remains asexual and destitute of the inner row of sharp pointed, lancet like teeth, and cannot successfully draw blood from an unbroken membrane. In keeping with this the larvæ are never found attached by the mouth to the intimal of the bloodvessel, and this membrane is never found marked with perforations, as happens to the mucosa from the teeth of the mature sclerostome (Sticker). With the growth of the larvæ and development of their teeth, they make their way along the arteries and escape from the Capillaries into

the bowel where alone they can attain sexual maturity and propagate their kind.

Neumann claims that they can encyst themselves a second time in the walls of the bowels and thus delay their intestinal career and development.

Wallach thought that in small worms of ½ inch or less, in the intestine, and having eggs, but without any vulva, he had found an imperfectly developed sclerostome, propagating itself by parthenogenesis.

Other Larval Habitats. The usual habitats, are the anterior and posterior mesenteric arteries and their branches, the cœliae axis, the posterior aorta, and the spermatic and ovarian arteries but they may be found in any portion of the arterial system, even in the cerebral divisions giving rise to structural and functional disorders according to their seat. The larvæ as well as the mature worms are occasionally found in the pancreatic or biliary ducts. Sometimes they occupy small pouches hanging from the peritoneal side of the bowel, formed by herniæ of the loose mucosa through the firmer investing muscular coat.

Pathogenesis. Lesions. These consist in perforations of the intestinal mucosa, cysts, aneurisms, embolisms, infarctions, congestions, exudates, and hæmolysis.

Irritation of the Mucosa. Like leeches, the mature worms are continually biting the mucosa and sucking blood and, when present in large numbers, hundreds, thousands or a million, create an aggregate of irritation which may determine violent, indigestions, tympanies, inflammations, obstructions, etc. The *abstraction of blood*, is so great with heavy infestments that profound anæmia and debility become marked features. The *toxins* secreted by the worms have the same effect. Chabert counted 1000 mature sclerostomes attached to a surface of two inches of the mucosa and estimated the entire number in that host as 1,000,000, so that such effects on blood and condition were inevitable.

Verminous Cysts. These are found in and under the mucosa but also under the peritoneum and in the mesentery, and vary in size from a pin's head, to a pea, or hazel-nut. Each contains an asexual worm in a mass of purulent detritus, or, if empty, may show the hole through which the parasite has escaped. The larva of the Scl. Tetracanthum lives in similar cysts.

Aneurisms. These are most common in the short undivided trunk of the anterior mesenteric artery just below its origin. It is not uncommon to find one on the root of the posterior mesenteric artery and less frequently, on the divisions of these within the mesentery. At times the posterior aorta has undergone a verminous dilation with thickened or calcified walls at the level of these vessels. In one specimen, in the museum of the N. Y. S. Veterinary College, there is a chain of such aneurisms no less than six feet long. Their prevalence depends on the distribution of Sclerostomes in a district : 1 % at Kasan, Russia, (Blumberg), 2 % Toronto (Duncan), 86 % Copenhagen (Krabbe), 100 % Toulouse, Rennes, (Neumann). They are very common in N. Y., and N. J. The aneurisms are found in all ages from six months up, and on breeding farms with swampy patches, in permanent pastures, they threaten the very existence of the industry. In such cases it is common to find a chain of aneurisms in the same subject, thus Bollinger found 168 aneurisms in 100 horses—153 in the anterior mesenteric artery and its branches, 4 in the cœliac axis and its divisions, 3 in the hepatic artery, 3 in the posterior mesenteric artery, 3 in the renal arteries and 2 in the posterior aorta.

The coagula in the aneurisms usually form in contact with the diseased intima, through which the worms enter and hence form tubular casts of the vessels, with a central lumen for the passage of the blood. The ends of the larvæ may be seen projecting from their galleries in the clots. In this situation the larva may attain to a length of $\frac{1}{3}$ inch, but remains sexually immature.

Embolisms. From fatty, granular or other degeneration in the blood-clots (thrombi), and from fermentations caused by bacteria introduced by the worms, masses are broken off and carried onward in the blood stream to block and arrest the flow in the smaller vessels. The emboli prove sources of mechanical irritation, aggravated in many cases by the presence of the larvæ and bacteria, so that new centres of congestion, inflammation, softening and dilation are formed, and multiple aneurisms developed. Again the more mature larvæ, reaching out toward a further development, leave their habitats in the aneurisms first formed, and traversing the smaller arterioles leading to the

bowels, finally reach a vessel too small to admit them and a small worm—embolism is formed, with all the series of morbid changes, congestion, infarction, effusion, circulatory stasis, and nervous disorder and digestive arrest.

Many varied morbid results may follow. Blocking of one or two mesenteric arteries may cause vascular stagnation in a considerable loop of intestine, with arrest of vermicular motion, secretion and digestion. Fermentation, gaseous distension, colic and even rupture may occur. Sometimes the area of blood stasis is more restricted, but exudation into the intestinal walls with permanent fibroid thickening and induration produces partial obstruction, impactions, constipation, sacculation above the point of stricture, and even more acute disorders. The blood stasis below the embolism determines loss of oxygen, excess of carbon dioxide, and unfitness of the strongly carbonized blood to keep up the normal functions (æration, nutrition, peristalsis, secretion, metabolism, digestion, elimination, etc.) and the affected part becomes swollen by exudate permeated by dark red or black vessels, with more or less extensive areas of blood extravasation and effusion. These extravasations may be so extensive that they appear like masses of clotted blood in the mesentery, the mucosa, submucosa, and beneath the peritoneum. A red effusion may be present in the abdominal cavity and the contents of the bowel may show blood clots and a dark red discoloration.

More distant lesions are congestions and softening of the liver and engorgements and hæmorrhagic centres in the spleen, in part at least superinduced by toxins produced in the bowels and diseased centres.

Extract of the head of the mature sclerostome dissolves the red globules of horse, ox, sheep, rabbit, or Guinea pig (Weinberg). This contributes largely to the anæmia, emaciation, and steadily failing resistance to the attacks of the parasites.

Symptoms. These vary with the seat of the larval parasitism. Invasion of the vessels of the brain, liver, spleen, pancreas or kidney will cause disorder of the functions of these organs respectively. But as invasion and symptoms are usually more closely related to the intestines the symptoms of this form may be especially noted.

A soliped, perhaps already known to harbor the sclerostome,

and showing the lines of dried mucus around the anus, is suddenly attacked with violent and persistent colic. He trembles, paws, moves his hind feet uneasily, kicks the abdomen, casts anxious looks toward the flanks, crouches, lies down, rolls, gets up and at once gets down again. The intensity of the suffering rapidly increases, the face is drawn and pinched, the eye is extremely anxious, the patient no longer lies down slowly, but throws himself down reckless of consequences, when down he is not quiet for a moment, but now on his breast, then on his side, then on his back, the limbs jerking violently, and the head turned first to one side and then to the other, he is a picture of extreme agony. If made to walk the same indications continue; he walks with head down and limbs semiflexed ready to drop at any moment, and often he will drop suddenly in spite of every effort to keep him on his feet. The pulse is at first strong and full, but, as extensive effusion takes place into the bowels or abdomen, or as the animal is poisoned by toxins, it becomes small, weak and it may be imperceptible. Breathing is quick and catching and the visible mucosæ are dark red. Sweating, which shows first at the elbows, flanks and back of the ears finally becomes general, the surface cold and the lower limbs especially so. Fæces may be passed at first, a few dry balls at a time from the floating colon or rectum, but soon they are suppressed entirely. Some patients strain to micturate, but pass little at a time.

In some cases the acute pain seems to suddenly cease, but there is no general improvement, the patient stands with head depressed, the eyes sunken and expressionless, ears lopped, cold perspiration, chilly limbs, unsteady balance, and imperceptible pulse. It implies merely a paralysis of the affected bowels in connection with the extensive congestion and extravasation.

Course. Duration. The more acute cases reach their acme with great rapidity, death may occur after two hours illness, and in others it may be delayed ten or even twenty-four hours. Such early deaths may be caused by indigestion and tympany, by volvulus or invagination, by excessive hæmorrhage, or by poisoning with toxic matter.

Recovery occurs when the vessel blocked is an unimportant one so that the circulation may be reestablished through collat-

eral trunks; or, when a more important trunk has been but partially blocked, and after a time either clears itself, or collateral circulation comes in with sufficient compensation. There is a more or less rapid subsidence of the colics and other symptoms, a free passage of urine, the rejection of fæces, it may be in a liquid, semiliquid or bloodstained condition but in quantity sufficient to indicate a restoration of intestinal tone. The patient begins to pick morsels of food and soon acquires his former appetite.

In some instances however recovery is incomplete. Trasbot has recorded a case of laminitis occuring within fifteen hours after the improvement, and in other cases there remain chronic debility and catarrh of the intestines. The appetite remains poor, there are occasional colics, the bowels are irregular, loose, or costive with small, hard, dry, glossy or mucus-covered balls. The back is arched, the belly tucked up, strength and vigor are deficient, and the patient spends much time in the recumbent position.

Complications of various kinds may follow as in other diseases of the intestines. Even after the best recovery, a relapse is always to be dreaded as the original parasitic cause remains and the animal is liable to be cut off at any time.

Treatment. This is very unsatisfactory as the primary source of trouble, the larvæ, being in the bloodvessels, cannot be reached by vermifuges that would be harmless to the host, and clots blocking the smaller intestinal vessels cannot be dissolved and removed. Moreover, although we could compass the death of the worms in the aneurisms, we would have their dead bodies as sources of septic change, blood coagulation and embolism.

But a certain number of cases are not necessarily fatal, and the worms in the bloodvessels have not an indefinite period of life, so that much can be done in both therapeutic and preventive treatment. During the attack we must be content to treat symptoms. French veterinarians have trusted largely to general bleeding, adopted at the very outset and to the extent of 6 to 10 quarts. This will temporarily lessen the vascular tension, more permanently dilute the blood, calm nervous excitement and in the most violent cases it might be tried as a means of tiding over the acute stage until a freer collateral circulation could be established.

Anodynes will be more generally acceptable in America. Two to four grains of sulphate of morphine or codeine may be given hypodermically with 1½ gr. eserin. 7 grs, barium chloride or 2 grs. pilocarpin or arecoline to secure a movement of the bowels.

To counteract intestinal fermentation ½ oz. chloral hydrate may be given in 1 qt. water by the mouth, and an equal amount by the rectum as injection.

Wet compresses to the abdomen or fomentations with water rather hotter than the hand can bear, or even the application of mustard, is sometimes useful as a soothing or derivative agent.

In the absence of morphia or chloral, laudanum, ether, chloroform, camphor or assafœtida have been recommended.

It is important to keep the patient on a soft, littered floor to prevent injury from his throwing himself down, and walking around may be resorted to for the same purpose.

Prevention. After recovery from an attack, and in every case in which a soliped is found to harbor the Sclerostoma equinum, measures should be taken to expel those present in the bowels, and to prevent the further entrance of embryos. The infested animal may be purged and put on two drachms each of tartar emetic and sulphate of iron every morning in a handful of feed half an hour before the first meal. After six doses he may take a second active purgative. In case of need, the addition of 6 grs. of arsenious acid and two drachms of powdered areca nut and a drachm of carbolic acid to each dose will render it much more affective. Infusion of quassia may also be used freely by both mouth and rectum as tonic and vermifuge. Other vermifuges, such as thymol, oleum-terebinth., male fern, kousso, etc., may be used in place of the above.

Even more important than the medication is the exclusion of embryos from food and water. No drinking water can be allowed from streams or ponds which have drained horse pastures (above all infected pastures). Open wells, ponds and cisterns in barn yards or stable yards are usually contaminated by the ova dried up and windborne in dust, and must be carefully avoided, also such water as has received surface drainage from cultivated land on which horse manure has been spread. Even in stables, the

ova from the fæces, dried up in dust and carried to the mangers, feed bins, hay mows and bales must be carefully guarded against by frequent thorough cleaning followed by sprinkling of anthelmintics, salt, mercuric chloride, iron sulphate, etc. Where infested water must be used it may be first boiled or treated with common salt, and passed through a brick filter.

The use of the same horse pasture year after year is to be strongly condemned, but above all on breeding farms, and where part of the pasture is swampy or springy. Wherever the sclerostomes have secured a local habitat, the land should, at intervals of one or two years, be put under a rotation of cultivated crops, to be laid down in grass again after four or seven years when the sclerostoma ova have been hatched out and have died a natural death. Where this is impracticable, change the horses to other pastures and depasture the infested land for several years by cattle or sheep which do not harbor the sclerostoma equinum. In all such cases it must be provided that no drainage can come from the infested pasture to the parasite-free pasture, and that no horse manure has for years past been put upon the latter as a top dressing. In northern latitudes the change to the clean pasture is best made in spring, when the solipeds have spent the winter in barns or yards, and have been subjected to courses of vermifuge medicine.

As infested animals cannot by one course of vermifuges, be divested of the larva in the cysts and blood vessels, successive courses of anthelminitics must be given at intervals of two or three months, to destroy and expel such worms as have escaped into the intestines in the interval.

Sclerostoma Tetracanthum, (*tetra four, akanthos thorn*). The 4-toothed sclerostome, has a mouth like that of the sclerostoma equinum, in showing a circular row of sharp triangular teeth, but it has in addition four large prominent papillæ from which the specific name is derived. It is further smaller than the equinum, the *males* being 8 to 15 mm. long, and the *females* 10 to 24 mm. The *male* has two delicate spicula of equal size and a shell-like clasping apparatus supported by rays. The *female* has the tail rounded but with a delicate sharp point, unlike the equinum.

Ovum an elongated ellipsis, twice as long as thick.

Habitat. In the cæcum and colon of solipeds often in great numbers, and in company with the sclerostoma equinum. It is distinguished from the latter by its smaller size, by the 4 large papillæ around the mouth, by the sharp spike on the otherwise rounded tail of the female, by the length of the elliptical ovum, and by the longer tail and more sluggish movements of the embryo. The embryos are hatched out in the intestine and may at once bore into the mucosa and encyst themselves, or escaping with the fæces they may reënter in the water and food and find a temporary home in the cysts in question. They are not known to wander into the bloodvessels like the sclerostoma equinum. The latter in the sexually immature condition live in the bloodvessels, while the former establish themselves in cysts in the mucous membrane, and in pill-like masses of solid ingesta in which they excavate for themselves a temporary home. The latter are the *nematoideum equi caballi* (Diesing), and *trichonema arcuata* (Cobbold), which the latter finally recognized to be the agamous larvæ of the *sclerostoma tetracanthum*. These larval asexual parasites must migrate into the bowels to attain sexual development and propagate their kind.

Pathogenesis. This is by no means so dangerous as the *sclerostoma equinum* since it leads to no blocking of the mesenteric vessels, yet when present in large numbers the countless wounds which it makes in the mucosa, and the irritation caused by the encysted larvæ, often produce congestion, indigestion, and enteritis. Apart from this, anæmia and chronic catarrh of the large intestine are common results of their ravages.

Symptoms. Beside the general manifestations of intestinal parasitism, there are the local symptoms of anal pruritus, the broken, twisted condition of the hairs at the root of the tail, the dried fur around the anus, and the passage of the specific worm with the fæces.

OTHER SCLEROSTOMATA.

From his Egyptian experience Looss records additional species of sclerostoma and their close allies. The following may be named :

SCLEROSTOMA EDENTATUM. THE TOOTHLESS SCLEROSTOME. This worm the name of which is rather paradoxical is but three-

fourths the length of the S. Equinum (*Male*, 23 to 26 mm. by 1.5 mm. ; *Female*, 33 to 36 mm. by 2 mm.), and is relatively thicker. The mouth capsule is beaker-shaped, not ellipsoidal. It is common at Cairo.

S. VULGARE is still smaller (*Male*, 14 to 19 mm. by 0.7 mm. ; *Female*, 23 to 24 mm. by 1 mm.). The tail is relatively more slender and pointed than the equinum.

Under the name of CYATHOSTOME (cup-mouthed) he names 12 varieties including the *Tetracanthum* ; under TRIODONTUS (three-toothed) two individuals ; and under GYALOCEPHALUS (hollow-head), one specimen.

Filaria Papillosa. Filaria Equina. This long, delicate, thread-like worm, diminishing slightly toward the ends, especially the posterior, has usually a clear refrangent silky aspect by which it is readily recognized. The globular head is terminated by a small mouth surrounded by eight conical papillæ arranged in opposing pairs. The *male* is 2 to 4 inches long, with tail rolled in three or four turns of a spiral, and furnished with 4 pre-anal and 4 post-anal papillæ on each side, and membranous alæ enclosing the two unequal spicula. The *female* 3 to 5 inches long, has a loose spiral tail, bearing three papillæ a terminal and two lateral ones. Vulva close to the mouth.

Ovum an elongated ellipsis. Ovoviviparous.

Habitat. This worm is often found in the peritoneum of solipeds, and Rudolphi claims that he found it in the intestine. It is also a commom parasite of other serous cavities as the pleura and arachnoid, and in the aqueous humor of the eye. It has also been found in the connective tissue beneath the peritoneum, and in the diaphragm.

Pathogenesis. As an intestinal parasite, no harm has been attributed to them; and when present singly in the serous cavities the same may be said of them. When very numerous, however, the host is usually debilitated and it is fair to attribute this to the irritation caused by the worm. In a weak subject suffering from cutaneous filariasis (Bursatti) a large number were found in the peritoneum (Baruchello). Swelled testicle and dropsical cord are often associated with the presence of filaria in the vaginal tunic (Steel, Pottinger), and the presence of filaria in the scrotum is usually associated with myriads of the same worm in the peritoneum (Macgillivray, Steel, Pottinger).

No effective *treatment* has been devised for filariases of the serous membranes. If the presence of the worms could be diagnosed, injection of a weak solution of carbolic acid, pyoktanin 1:1000 quassia infusion or other non-irritant vermifuge might be tried. Or one might try the effect of a long course of arsenious acid given by the mouth.

Anguillula. Rhabdonema. To this class has been ascribed the small worm formerly described as *Oxyuris vivipara.* Only females have been found 2.5 mm. long by 0.4 to 0.8 mm. thick, sexually mature, and with a few ova, and even embryos in the uterus.

DIPTERA LARVA.

Gastrophilus. The various species of bots (gastrophilus) in passing out of the body have to traverse the intestines and thus in early summer they are temporarily intestinal parasites. Sometimes these give rise to more or less irritation by hooking on to the sensitive mucosa, and in other cases they assist with the ingesta in blocking the lumen, and setting up obstruction and indigestion.

For the *treatment* of such cases see "*parasites of the stomach.*"

Helophilus Pendulinus. *Rat-tailed maggot.* On several occasions the hanging helophilus has been passed by the horse. It is readily recognized by the long, tail-like prolongation from one end of the bot-like body. Its presence has no pathological significance.

Amphistoma Hawkesii. (Cobbold). Body translucent, pinkish, 3 lines long by 2 lines broad, with oral and caudal suckers.

Habitat: Intestines of elephants especially the young, under improper feeding, watering or environment.

Symptoms. Loss of condition, eating earth, diarrhœa which may become persistent and profuse, the fæces swarming with the parasite, œdema appears about the head and shoulders and the patient dies in marasmus.

Lesions. The amphistomata are present in myriads attached to the mucosa as well as free in the large intestine. The mucosa

shows areas of congestion, gelatinoid exudates between the tunics. Other parasites are also present. The body cavities and organs are more or less dropsical and anæmic, while the blood in the heart and large vessels is thin, pale and watery, and the clots diffluent.

Prevention is to be sought in restricting the young to pure, or boiled water, to green food from dry soils only, or to dry food, and by a regular liberal supply of salt.

Treatment, by the free use of vermifuges.

INTESTINAL PARASITES OF CATTLE.

Actinomycosis of demi-canal, and intestine. *Saccharomyces Guttulatus*, elliptical cells, with refrangent spots, single, pairs, or chains; harmless. *Aspergillus Fumigatus* in pea-like or miliary nodules of small intestine or mesenteric glands. *Coccidium Oviforme* and *Perforans Amphistoma Tuberculatum* in intestine; India *Bilharzia Crassa:* Ova in papillary swellings of intestines, anus and urinary bladder; mature trematode in blood of ox; India, Egypt, Italy; Syngamous. *Prevention:* As for distomatosis. *Tænia Denticulata:* Unarmed, 8 to 15 inches; segments broadest posteriorly, causing serrations; larva unknown; in small intestine, injurious to young. *T. Expansa:* Short, broad, thin, transparent, unarmed head; in small intestine, may injure calves. *T. Alba:* Smaller than expansa, larger head, crescentic suckers; thicker, longer, narrower, ripe segments; small intestine; ox and sheep; Italy, France. *Treatment:* In young, usual tæniacides. *Ascaris Bovis:* Reddish white. 4 to 6 inches; narrowed ends, triangular mouth, three buccal papillæ with serrated borders, tail conical, 30 papillæ in front of anus; in small intestine, in young mostly; causes indigestion, diarrhœa and enteritis. *Treatment:* Oil of turpentine, tartar emetic, areca nut, male fern, potassium picrate. *Strongylus Ventricosus:* Vulvar enlargement; in small intestine; ox, stag. *Œsophagastoma Inflatum:* Dilated neck with two alæ; mouth round with six papillæ; in colon; causes nodules. *Uncinaria Radiatus:* In Europe and America (Texas), dwarfing growing cattle, causing anæmia and death; ¾ to 1 inch; chalky; head bent dorsad; armed mouth turned upward; upper lip short; oviparous, eggs transparent, ovoid. *Symptoms:* Unthrift, anæmia, vertigo, palpitation, dropsy, colic, scouring; worms and ova in manure; washed and precipitated. *Treatment:* Thymol, and purge. *Prevention*: Clean buildings, whitewash, water from deep wells, cemented, closed, pasture by different genera in successive years, or plow and put in rotation of crops. *Trichocephalus Affinis:* Hair—head, alæ on head, 6 to 8 cm. long; oviparous; ova with two transparent polar buttons. *Treatment:* Vermifuge; change pastures, and secure pure water. *Trichina Spiralis: Filaria Cervina:* Lacks

the 4 post-oral papillæ of the papillosa. Peritoneum, ox, stag, deer; ovoviviparous. *Echinococcus Veterinorum:* In peritoneum, liver, etc. *Cysticercus Tenuicollis:* Larva of T. Marginata, Peritoneum. Head shows active movements on long, thin neck; only hurtful when present in great numbers; hæmorrhagic hepatitis or peritonitis. *Prevention:* Deny raw offal of herbivora to dogs. Keep dogs from pastures, fodders and water supplies; use vermifuges on dogs. *Distoma hepaticum.*

Besides the various bacteridian ferments and the sporozoa and infusoria similar to those of the horse, cattle suffer from *Actinomycosis, fungi, cestoids, trematoids* and *nematoids*. *Coccidiosis* has been already described.

ACTINOMYCOSIS.

This has been described by De la Pace as occurring in the intestine of cattle. In a recent case of repeated and fatal choking above the cardia, in the practice of Dr. Ryder, we found extensive actinomycosis of the demi-canal, which had occasioned the choking. Whenever this organism can be diagnosed, here as elsewhere it may be treated with good prospect of success by a prolonged course of potassium iodide.

FUNGI.

Saccharomyces Guttulatus. This is normally present in the intestinal contents of cattle, and cannot be accused of any injurious effect. It consists of elliptical cells, of a dark brown opaque appearance and a few brightly refraugent points. They may be isolatcd, in pairs, or in chains.

Aspergillus Fumigatus. This fungus, which proves so destructive as a pulmonary parasite of birds and their feeders, has been found in miliary nodules of the small intestine and mesenteric glands of cattle (Franck). The nodules, the size of a pea, were often calcified and were distinguished from tubercles by their greenish color, and by the presence of a central drop of pus mixed with the mycelium of the aspergillus.

Diagnosis in life is well nigh impossible, otherwise a treatment by potassium iodide, or sulphites would be indicated. Its presence in a carcase should entail its condemnation, as liable to infect the human being.

INTESTINAL SPOROZOA IN CATTLE.

Cattle suffer from **Coccidium Oviforme** and **Coccidium Perforans**, the ravages of which are described elsewhere. (See **Coccidian Enteritis.**)

INTESTINAL TREMATOIDS IN CATTLE.

Amphistoma Tuberculatum. This is found in the intestines of cattle in Hindostan. It is a congener of the amphistoma conicum of the rumen, which it resembles.

Bilharzia Crassa (*crassus thick* schistosoma bovis) is a distinct larger variety of the Bilharzia Hæmatobia which lives in the blood of man in Africa and India and produces chylous urine. The *ova* are more elongated, .16 to .18 mm., are found in papillary elevations of the mucosa of the urinary bladder, intestines and anus in Egypt (Sonsino), Sicily (Grassi) and Calcutta (Bomford), causing intestinal catarrh, congestion, ecchymosis and thickening of the mucosa in sheep and cattle. It is supposed to cause much of the prevalent hæmaturia in different parts of Africa and Southern Asia. It has also been found abundantly in Italy (Grassi and Rovelli).

The mature worm found in the blood is easily recognized by its syngamous habit, the male clasping the female in a ventral canal or furrow, from the ends of which the delicate threadlike extremities of the female project. As with other trematoids the embryos enter the body with the drinking water and should be guarded against in a similar manner. (See Disomatosis).

INTESTINAL CESTOIDS IN CATTLE.

Tænia Denticulata. Moniezia Denticulata (serrated tapeworm). An unarmed tape-worm about 8 to 15 inches long, 3 or 4 lines broad, with an expanded head (1.125 mm.), consisting of four globular masses supporting four suckers, the segments nearest the head 10 to 20 times as broad as long. Their posterior border has a waving outline, and each widens from before backward, so as to give the lateral border of the parasite a denticulated appearance. The ripe segments are very thick, and gorged with cuboidal *ova* 68 to 80 μ in diameter. *Larva* unknown.

Habitat. The small intestine. The most common tape-worm of cattle.

Pathogenesis. It may cause considerable intestinal irritation, especially in the young, and has been known to induce epilepsy (Eggemann).

Tænia Expansa. Moniezia Expansa, The broad tapeworm of ruminants may grow to 12 or 18 feet in length (100 feet, Rudolphi), but young specimens may be very short and attenuated, thin and translucent. From a delicate filiform neck it may reach a breadth of 2 to 2½ cm. in the mature caudal segments. The unarmed head is small, round, with four suckers, having elongated slit-like openings. The segments have a waving posterior border. *Ova* polyhedral, with transparent contents; 50 to 80μ in diameter. *Larva* unknown.

Habitat. Small intestine.

Pathogenesis. Rarely injurious to cattle, but often very numerous in small ruminants and disastrous.

Tænia Alba. (Alba white). **Moniezia Alba** (**white tapeworm.**) This is distinguished from the broad tænia by its small size, 18 inches to 7 feet, by its larger head (1.15 to 1.40 mm.), by its hemispherical suckers, by its distinct neck, and by its thicker, longer and narrower segments (10 to 12 mm. broad). *Ova* 48 to 58μ in diameter.

Habitat. Small intestine of cattle and sheep in Italy (Perroncito), and France (Moniez, Railliet, Blaise).

Tænia Planissima. Moniezia Planissima. Length 1 to 3 metres, thin, translucent, with yellowish tint. Head quadrangular, unarmed. Ripe segments 12 to 26 mm. broad, by 1 to 1.75 mm. long. Sucking discs oval. Ova 63μ in diameter.

Habitat. Small intestine of sheep and cattle in America.

Treatment of Tænia in Cattle. As in all ruminants the three first stomachs stand in the way of successful treatment, but in the young in which these reservoirs are comparatively undeveloped, an easier success can be secured. The common tæniacides may be given:—male fern, kamala, pomegranate root bark, kousso, pumpkin seeds, oil of turpentine, phosphate of strontia, salicylate of soda, naphthalin, preceded and followed by an active purgative.

INTESTINAL NEMATOIDS IN CATTLE.

Ascaris Bovis. Ascaris Vituli (*vitulus calf*). The ascaris of the calf is a reddish white worm of the diameter of an earth-

worm and 4 to 6 inches long (male), or 7 to 10 inches (female). The head is small and distinct and mouth triangular with three prominent lips having denticulated edges. Caudal end conical. *Male* has two spicula and membranous alæ. In front of the sub-terminal anus are two rows of about 30 papillæ. *Female* has the vulva close to the anterior sixth of the body. *Ova* 75 to 80μ in diameter.

Habitat. In the small intestine and especially in the young. Exceptionally in the abomasum.

Pathogenesis. Rarely hurtful to adults, but when present in large numbers cause epizootics of indigestion, diarrhœa and enteritis (Valisnieri), and even rupture of the bowel in calves (Descomps).

Treatment. In calves give the same treatment as in monogastric animals. Empyreumatic oil 8 to 12 grams in mucilaginous emulsion at night, followed next morning by a purgative (Guittard). Oil of turpentine 2 to 4 drs. in milk or oil. Tartar emetic 1 scr. followed by a purgative. In weak calves areca nut 2 drs. twice daily. Cadeac advises the following: male fern 8 to 15 centigr., tartar emetic 50 centigr., tansy root 15 grams, potas. picrate 1 gr., kamala 2 grs., strontia phosph. 10 grs., naphthalin 1 gr. Give at one dose.

Strongylus Ventricosus (venter belly). So called because of a prominent enlargement around the vulva which gives the appearance of a distended abdomen. Body filiform, male 6 to 8 mm., female 8 to 12 mm. Head small with lateral alæ; mouth small; no labial papillæ. Integument has 14 longitudinal ridges. *Male* with caudal pouch. *Female* with vulva behind the middle of the body.

Habitat. The small intestine of cattle and stag in Europe.

Pathogenesis. Unknown.

Strongylus Filicollis. (See worms of abomasum).

Cooperia Curticei. Characterized by its relatively thick head, the cuticle of which is annulated and uniformly thickened so as to cause a material enlargement. It differs from the Ostertagia in the absence of cervical and prebursal papillæ; by the marked depression at the crossings of the longitudinal and transverse striæ, giving to the cuticle a distinctly beaded appearance; by the wide separation of the tip of the ventro-ventral

ray of the bursa, from the tip of the latero-ventral ray; by the peculiar branching of the dorsal ray of the bursa into two prominent main branches, curved to form a lyre shaped or horse shoe shaped object, each bearing a branch which originates near the junction of the main branch with the stem and extends ventrally into a vesicular thickening on the inner surface of the bursa. The spicula are 135 to 145μ long.

Habitat. Intestinal canal of cattle in Gulf States.

Cooperia pectinata. With the general characters of the C. Curticei and C. punctata, with which it would be most readily confounded, but for the facts that the spicula, double, are larger (240 to 280μ in length), and that the middle portion of each spiculum has a prominent ventrally projecting edge with well marked corrugations at right angles to the border, which give it a pectinated or toothed appearance; the terminal part of the spiculum is relatively much more slender. *C. Curticei* has also a ventral crest on the spiculum with lateral corrugations but these are both slight and inconspicuous as compared with the C. pectinata. In C. punctata there are no transverse corrugations of the spiculum. The spicula of C. pectinata (120 to 150μ) are much shorter than those of C. Curticei.

Habitat. Small intestine cattle.

It may prove to be identical with the Strongylus Ventricosus which Rudolphi found in the small intestine of cattle and stags in Europe.

Other Cooperia. Beside the above must be named the *C. punctata*, and *C. Onchophora* found in the small intestine of cattle in Europe.

Œsophagostoma Inflatum. This is easily recognized by the marked dilatation of the neck over both head and body. Mouth circular with prominent ring bearing 6 papillæ. Neck followed by two lateral alæ. *Male* 14 to 15 mm. with slightly trilobed caudal bursa; *Female* 16 to 20 mm. with vulva just in front of the anus, and surrounded by a prominent circular ridge.

Habitat. Colon of cattle.

Pathogenesis. Unknown.

Uncinaria Radiatus (Uncinatus hooked). This parasite was found by Rudolphi in the duodenum of a calf, but for long was considered of no consequence as a pathogenic factor. Recent

observations of Stiles especially have shown, as might have been expected of such a parasite, that all that was wanted was the opportunity for encrease and diffusion to make it a virtual scourge. In examining the unthrifty cattle of DeWitt, Gonzales, Victoria and Calhoun Counties, Texas, he found the worm in the upper part of the duodenum of half the animals subjected to necropsy. The habit of the genus of sinking the teeth into the mucosa and sucking strongly by the aid of the muscular œsophagus, and the oozing of blood through the many orifices that have been sucked and abandoned, deplete the vascular system, the recuperation of which is interfered with by the local irritation and the disturbance or arrest of digestion in this the most important part of the alimentary canal. The bovine victims therefore fail to grow, mature, and develop their natural improved family form, or they even become the subjects of extreme anæmia and death. See U. Cernua.

Male 15 mm. long; female 25 mm. (1 inch, Stiles) and thicker than the S. Contortus. It has a chalky white color, and shows the distinctive characters of its genus: head bent (hooked) sharply dorsad near the end; round mouth turned so as to open upward, the upper lip being shorter, furnished with a chitinous lining and bearing two ventral teeth near the base, and others near the protruded, upward-curved, ventral border. Dentations may also appear on the upper border. This is followed by a strong muscular gullet, terminating behind in a fusiform dilatation. The male has two spicula and a membranous expansion supported by eleven rays. Oviparous, eggs ovoid, with thin transparent shell. Embryos may be encysted in the mucosa.

Symptoms. These are extremely indefinite beyond the stunted growth, the spare angular body, deficient in muscle, the unthrifty hide-bound skin, and the bloodlessness of the visible mucosæ generally. In some cases when the worms are very numerous and the irritation extreme and extensive, colics and scouring may be induced, especially in the young, but usually the manifestations are those of anæmia, and its resultant troubles. There may be giddiness, unsteady or staggering gait, palpitation, anæmic cardiac murmur, thrill with pulsation, and even dropsical effusions in the limbs, under the chest or abdomen, between the branches of the lower jaw, around the throat, in the eye-lids, or in one of the

serous cavities. The most conclusive evidence, however, is the finding of the worms or their eggs in the manure passed. As the small size of the worms interferes with their discovery in this way, it is well in cases of anæmia or cachexia to wash the fæces in a succession of waters letting the sediment fall to the bottom each time before the supernatent water is poured off. In this way the worms and eggs fall and remain with the precipitate, so that when all the floating material and the fine suspended and coloring matter, that serves to hide the worms, have been washed out, the parasites are found in the clear granular and fibrous debris where they are easily recognized. The eggs are usually found in the superficial layer of thin sediment. A little of this, or even of the mucus, or the surface layer from the fæces placed under the microscope may reveal the elliptical ovum, characterized by its thin, smooth, transparent skin, and its yolk usually already segmented.

For man, in addition to the above, Stiles advises to evacuate the bowels by a dose of oil, following one of thymol, to collect all the fæces, wash and sediment them several times in a bucket, and examine the precipitate for the worms.

Treatment. This is the same as for other intestinal worms. Stiles especially recommends thymol followed by an oleaginous purge.

Prevention. The thorough cleansing and lime washing of the buildings is important and the supply of water from deep wells, well cemented and closed at the top to prevent the entry of embryo worms and their eggs. The pastures should be occupied by different genera of stock in successive years, so that the worms will perish, for lack of their proper hosts, or if permanent pastures are not a necessity, the fields should be plowed up at intervals of a few years, and subjected to a rotation of crops before being again laid down in grass. In the last year of such rotation cattle manure should not be applied on fields that are to be laid down for cattle pasture in the ensuing year. (See U. Cernua).

Tricocephalus Affinis. Whip-Worm of Cattle, Sheep and Goats. This worm is so named because of its affinity in form to the Tricocephalus Dispar of man. It is a small worm, 6 to 8 cm. long, but the cephalic two-thirds are extremely thin and hair-like, and the thick portion is usually curved into a close coil at the tail. The head usually shows two lateral, transparent,

membranous expansions which are characteristic. The male has a single long spiculum with trumpet-shaped sheath covered with reversed triangular spines. Female with blunt tail. Vulva at point of union of attenuated and thick portions of body. Oviparous ; eggs elliptical with two transparent buttons at the two ends ; length 0.077 mm.

Leuckart has traced the development of the eggs in a damp medium in fifteen days in warm weather, but often after a delay of months in winter. In this way they easily survive from year to year out of the body, as well as in the large intestine (cæcum and colon) which form their usual habitat.

They are not usually numerous nor noticeably injurious in adult cattle, but may be present in large numbers in sheep and goats, and especially in the weak and immature.

Pathogenesis. This parasite attacks ruminants generally, hence the presence or absence of the whole family of polygastric animals must be considered in any attempt to extirpate them from a locality. The bovine animals may appear to suffer little themselves, and yet keep a pasturage, river or locality stocked with a worm that proves most injurious to the smaller ruminants. They attach themselves by burrowing the head and neck in the mucosa, and when present in large numbers cause great irritation, indigestion, anæmia and emaciation.

Treatment is called for more frequently in the small ruminants ; in cattle, rather as a means of extirpating the parasite from the locality and protecting sheep from its ravages.

Equally important is it to destroy or remove the ova which have escaped with the fæces and which in fifteen days can develop into embryo worms ready to start a new career in the bowels.

Strongyloides Bovis and Agrostomum Vryburgi. Vryburg records the prevalence of these worms, separately or together in the same animal, among cattle in Sumatra. They pass from animal to animal, with the food and water. It is not improbable that this like other strongyloids may also enter through the skin in its larval form. (See S. Ovis). The symptoms of their presence vary with the number of the worms, being often very obscure, and in other cases manifested by a chronic diarrhœa. The finely attenuated, hairlike worms and their ova may be found in the fæces.

Treatment by thymol, creosote, ol. terebinth, arsenic, and areca nut was not satisfactory; the best results were obtained with A. Vryburgi. Unless measures of exclusion are enforced America might suffer by importations through the Philippines.

Trichina Spiralis is sometimes found in the intestines and muscles of cattle, but so rarely that it requires no special notice.

Undetermined Embryo. Dreschler found in the intestinal mucosa of cattle small caseated nodules, like pin-heads or peas, each containing a larva of 1 mm. long. Neumann suggests that they may be larvæ of strongyles. Possibly œsophagastoma.

Filaria Cervina. FILARIA OF THE STAG. This is found in the peritoneum of cattle, deer and stags. It differs from the Filaria Papillosa of the horse by the absence of the four post-oral papillæ and of integumentary striæ, and by the termination of the caudal papillæ of the female in a series of short, blunt points, preceded by two lateral longer papillæ. *Male*, 5 to 6 cm.; *female*, 6 to 10 cm. *Ovoviviparous*. *Pathogenesis* unknown.

Echinococcus Veterinorum. Echinococcus Polymorphus. This is a common parasite of the peritoneum in cattle. (See under "Diseases of the Liver").

Cysticercus Tenuicollis (tenuis delicate, collum neck. **Diving Bladder Worm.** This is the larval or cystic form of the tænia marginata of the dog and is a common parasite of the ox's peritoneum. It has a round or elliptical caudal sac of 15 to 50 mm. in diameter, with an orifice in which the head and long, thin neck of the parasite are invaginated. The active movements of the head in this sac have given rise to the name of *diving bladder worm*. It may be observed when the fresh cyst is placed in a saucer of milk-warm water. Usually but one or two cysts are found and no morbid symptoms are noticeable, yet when the ripe segments of the tænia are given so as to develop many cysts, these may produce diffuse hæmorrhagic hepatitis or peritonitis.

Prevention. Prevent dogs from eating the raw offal of herbivora. Destroy and expel the tapeworm of the dog with tæniacides. Avoid keeping dogs in numbers where stock pasture, where fodder for stock is raised, or where the water for stock runs or stands.

Distoma Hepaticum. Morot has found a specimen encysted under the parietal peritoneum of a cow.

INTESTINAL PARASITES IN SHEEP AND GOAT.

Saccharomyces Guttulatus. Lamblia Intestinalis. Coccidium, perforans and *oviforme. Tape-worms: T. Expansa, Alba* and *Benedini. T. Fimbriata, T. Vogti. T. Ovilla. T. Centripunctata:* Uterus shows white in centre of ripe segment. *T. Globipunctata. Intestinal Round Worms. Ascaris Ovis. Strongylus Filicollis:* Front part of body very thin; in duodenum and small intestine; sheep, goat, numerous; causes irritation, diarrhœa, anæmia, emaciation, dropsy. *Prevention; Treatment. Strongylus Ventricosus. Œsophagostoma Venulosum* in goat, sheep, roe-deer. *Œ. Columbianum:* Narrowed at ends, mouth large, six papillæ, two rows teeth, 24 each; the sexually immature occupy the nodules in and under mucosa; moult three times, mature in intestines; ova escape with fæces; embryo forms nodules on large and small intestines, with greenish debris often calcified; also in mesentery, lymph glands, liver; abundant in winter. Cause debility, emaciation, diarrhœa. *Prevention:* Do not pasture a field with sheep for two successive years; avoid drainage from infested fields; put land under rotation; pure water from deep wells; salt freely. *Treatment. Uncinaria Cernua:* Armed mouth opening upward through bend of body; 14 to 28 mm. long; in small intestine; sheep, goat; in Gulf Coast States; ovum hatches in 15 days in manure; devitalized by frost; embryo moults four times; living in water or moist earth. *Symptoms:* Low condition, anæmia, debility, weakness, dropsies, etc. *Treatment:* Thymol, male fern, gasoline, areca nut, generous diet. *Prevention:* Admit nothing from infected flocks or districts; avoid infested fields and water, or those fertilized with manure of sheep folds; newly seeded pastures yearly; keep from wet pastures; salt freely. *Sclerostoma Hypostomum:* Round mouth turned down, double row teeth, 10 to 24 mm. long; in large intestine and ileum; sheep, goat, chamois, argali, roe buck, etc.; eggs discharged with fæces. Cause local congestion, catarrh, anæmia, emaciation. *Prevention: Treatment: Tricocephalus Affinis; Anguillula Longus:* Intestinal parasites of goat.

Saccharomyces Guttulatus is found in the intestinal contents of sheep as well as of cattle.

Lamblia Intestinalis. This pyriform, flagellate infusorium (9 to 16μ by 4 to 7μ) has been found by Blanchard in the intestines of sheep. It is common in man, and rodents (rats, mice, field mice). It has three flagella attached around the sucker and one extended back from the posterior of the body. Pathogenesis unknown.

Coccidium Perforans and **Coccidium Oviforme** are both found in the intestines and may cause congestion and inflammation.

CESTOIDS. TAPE-WORMS.

As many as eight different species of tæniæ infest the intestines of sheep. All are unarmed and in no case has the cystic form been discovered.

Tænia (Moniezia) Expansa and *Tænia Alba*, already described as occuring in the ox are also common in sheep. One or two may do little harm but when present in large numbers they may prove very destructive.

Tænia (Moniezia) Benedeni. (A) Head small, globular, with four suckers but no proboscis nor hooklets; narrow neck; broad, short, thick segments. Length up to 12 feet. *Ova* polyhedral 75 to 80μ in diameter.

Tænia (Thysanosomum) Fimbriata. Th. Actinioides. (See Parasites of Liver).

Tænia Vogti. This is only known by a headless specimen described by Moniez. It measured 17 inches, was very thin and flat, and its mature segments were 5 mm. long, by 2.5 mm. broad.

Tænia (Thysanosomum) Ovilli (Rivolta), *T. Giardi* (Moniez), *T. Aculeata* (Perroncito). Head tetragonal, without rostrum or hooklets: neck long and narrow; segments short and broad, up to 10 mm. broad and 1.5 mm. long: genital pore single, and irregularly alternated, right and left. Length 6 feet or more. *Ova* round or ovoid.

Tænia (Stilesia) Centripunctata. This receives its specific name from the presence of a raised white spot representing the uterus in the centre of each ripe segment. The head is tetragonal, unarmed, and followed by a narrow neck, gradually widening in the body to 2 or 4 mm. and again narrowing to 1 mm. The length of the segment encreases to the last (.3 mm.) as does also the thickness. Length 10 feet. *Ova* few and globular.

Tænia (Stilesia) Globipunctata. Head with four suckers; unarmed; no neck: mature segment 2 mm. broad, .17 mm. long. Each segment has two opaque points formed by the double uterus. Body delicate and transparent, 15 to 20 feet long. *Ova* globular.

Moniezia Planissima. Transparent, 1 to 2 metres.

Moniezia Neumanni. Filiform neck.

Moniezia Nullicollis. No neck.

Moniezia Trigonophora. Thick segments.

Neumann tabulates these tænia as follows :

- **Two genital pores in each segment. With neck.**
  - Orifice of sucker elliptical or linear
    - Posterior border of segments undulated.
      - Broad segments 12 to 25 mm., broader than long. **Tænia (Moniezia) expansa**
      - Segments very short, translucent, posterior angles broadest, margin serrated. **T. Denticulata. (M. planissima)**
    - Last segments very thick 16 mm. broad. **T. (M.) trigonophora**
  - Suckers with round orifice.
    - Thick segments, opapue, becoming longer than wide, 10 mm. wide. **T. (M.) alba**
    - Thick segments, opaque, always broader than long. **T. (M.) benedeni**
    - Anterior part filiform ripe segments 16 mm. broad. **M. Neumanni**
  - Posterior border of segments fringed. **T. Fimbriata. Thysanosomum actinioides**
- **No neck.** **T. (M.) nullicollis**
- **One genital pore in each segment.**
  - Ripe segments longer than broad. **T. Vogti**
  - Segments always broader than long.
    - Ripe segments 5 to 10 mm. broad. **T. (Th.) Giardi. T. Ovilla**
    - Ripe segments 1 to 2 mm. broad.
      - Transparent in median line. **T. (Stilesia) Globipunctata**
      - Opaque in median line. **T. (St.) Centripunctata**

INTESTINAL NEMATOIDS OF SHEEP.

Ascaris Ovis. Very rare. *Male*, two to three inches long ; *Female*, as much as 4 inches and 2 mm. thick. Head small, mouth trilobate, the upper lobe with two papillæ, the others with one each. Vulva toward the anterior third of the body.

Strongylus Filicollis (filum thread, collum neck) **Nematodirus Filicollis** (Rudolphi 1802). The thread-necked strongyle is so named because of the extreme tenuity of the part succeeding the small head, which has two small, translucent, lateral alæ. *Male*, 8 mm. to 15 mm. long, filiform with two spicula and broad membranous clasping organ. *Female*, 16 mm. to 24 mm. long ; head and neck filiform ; caudal portion somewhat thicker ; tail conical, pointed ; anus close to caudal end, with vulva in front of it. *Ova* elliptical.

Habitat. Duodenum and small intestine of sheep and goat (exceptionally in the fourth stomach). Often present in vast numbers in sheep affected with strongylus contortus (stomach), and strongylus filaria (bronchia). It abounds in autumn and winter.

Pathogenesis. It causes much intestinal irritation with diarrhœa, and by its abstraction of blood and producing indigestion is a fruitful source of anæmia, emaciation and dropsy. Associated as it often is with the destructive strongyli of the lungs and stomach, it largely contributes to the verminous epizoötics and enzoötics which are so common in sheep.

Prevention and *treatment* will be the same as for strongylus contortus.

Strongylus Ventricosus. Curtice found this to be common in the small intestine of sheep in autumn and winter. (See "Worms of the Ox.")

Œsophagostoma Venulosum (*venula a small vein*). Mouth circular, bounded by a prominent ring with six papillæ. The neck shows an ovoid enlargement followed by two lateral, narrow alæ. *Male*, 15 mm. long, with broad, trilobate, caudal bursa. *Female*, 24 mm. long. Vulva in front of the anus.

Habitat. Intestine of goat, sheep and roe deer. Rare.

Œsophagostoma Columbianum. Body narrowed at both ends. Head bent to one side. Mouth terminal, large, round, with six papillæ and a chitinous ring, and two rows of teeth, twenty-four in each, and the outer row the larger. Œsophagus triangular. Neck has a ventral fold and extending back from this for one-fourth the length of the body are two lateral alæ. *Male*, 12 mm. to 15 mm. long, with two spicula and a broad hemispherical bilobate pouch. *Female*, 14 to 18 mm. long; thicker than the male; tail acute; anus midway between the vulva and the tail. *Ova* elliptical 0.09 mm. long.

Habitat. Cooper Curtice discovered this parasite in 1888 in the nodules on the intestines of sheep at Washington, D. C., and later free in the intestines. It is very common in American sheep, north as well as south, the presence of the nodules being the rule rather than the exception in sheep killed in New York. Its history is unknown from the passage of the egg with the fæces to the entry of the embryo with food or water and its encysting

itself in the walls of the intestines. From the cyst, however, it escapes into the intestine, reproduces its kind and dies. It is especially common in the cæcum and colon during autumn and winter, but it may invade any part of the small intestine. It moults three times, once before it acquires mouth and digestive organs, once after such acquisition, and once in becoming developed into the mature form.

Pathogenesis. The embryos are first found encysted in pin-head-like submucous nodules; in larger nodules the encysted worm is surrounded by some greenish debris; in still larger pea-like masses the greenish cheesy debris forms the principle constituent amid which the worm is found with difficulty or not at all, having already migrated into the bowel. The larger nodules are usually partially calcified. The rounded nodules may be aggregated in clusters, or there may be a canal filled with the cheesy material representing a worm track. In some instances the mucosa has sloughed and the cheesy mass protrudes into the intestine. Curtice has traced worms even to the lymph glands of the mesentery and believes that most of the encysted worms perish, while the few that survive and escape into the bowel, do so in the spring when their ova, escaping from the body, find conditions more favorable to their survival outside.

Diarrhœa and emaciation are results of the presence of these worms in large numbers, and at the best the general condition of a flock must be largely reduced by this parasite, yet it is surprising how all but universally the bowels are affected in sheep killed in good condition. The tendency of sheep in America to lose their old world rotundity, and to become more lank and leggy often depends in no small degree on the ravages of this and other parasites.

Prevention. Must be sought first in the elimination of the mature worms from the bowels by the use of the same agents as in strongylus contortus. The avoidance of surface waters and wells receiving leaching from the surface is all important. The same land should not be pastured by sheep two years in succession. Put in a rotation of cultivated crops, or if that is impossible, divide the pasture in two and use one-half on alternate years. Give salt at will, and water from troughs rising above the surface of the ground, and always moderately salted.

Uncinaria Cernua (Cernus bent down). **Uncinaria of Sheep. Dochmius Cernuus.** This is a small worm with yellow or red, rigid body, and the head and neck abruptly bent dorsad so that the mouth opens upward. Mouth round ; buccal cavity chitinous with four curved teeth, two on each side, the ventral pair the stronger. Two other teeth are situated deeper on the ventral aspect. *Male* 14 to 18 mm. long ; spiculum long, curved, fenestrated and surrounded by an infundibuliform bursa. *Female* 20 to 28 mm. long, with vulva in front of the middle of the body. Ova elliptical, transparent, often segmented.

Habitat. Small intestine of sheep and goat, most commonly with heads buried in the mucosa, sucking blood. Sometimes in large intestine. Stiles reports the worm as prevailing in sheep in the Gulf Coast States, along with the Strongylus Ostertagi. In keeping with the common experience with other species of the bloodthirsty Uncinaria, he found it extremely injurious "doing more harm than all the other parasites of the sheep."

Life-History. Though the life-history of the U. Cernua has not been especially investigated, there can be no doubt that it follows the general rule of the genus uncinaria.

The *ova*, laid in the intestine, usually undergo segmentation in the ingesta but are expelled in this condition in the fæces. Young worms direct from the egg never reach maturity without leaving the intestine.

The *rhabditiform embryo* escapes from the egg after 15 days, hatching in the manure or in a warm moist environment though development may be arrested for months in cold weather. The egg is destroyed in too much water or by frost. The embryo shows the common embryonic œsophagus of the strongyli : *first*, an elongated large section, followed by, *second*, a narrow, thin middle portion ; and *third* a dilated oval or globular bulb armed with triradiate chitinous projections. This last has the appearance of a triturating cavity or gizzard.

The *embryo* lives in water or moist earth, and before reaching maturity it passes through four successive moultings. The buccal end is thick and blunt, the tail long and finely pointed. There is a distinct digestive apparatus ending in anus 50μ in front of the tail. On the second or third day it makes its *first moulting* and on about the fifth day its *second* having attained a length of 480μ

by 30μ. The chitinous lining of the buccal cavity and œsophagean bulb disappears, through the skin can be seen three lips each bearing two papillæ, the tail is shorter and blunter, and the body contracts and loosens from its outer skin ("encystation"), preparatory to the *third* moulting. The young uncinaria is now prepared to invade the intestine and if taken in by the sheep or goat, it advances toward maturity; otherwise it perishes in no great length of time. Looss, however, has succeeded in keeping them alive at this stage for thirty days in water. He also supposes that they can be dried up and carried on dust without loosing vitality, but as drying is usually fatal to them, Stiles considers this as highly improbable.

Taken into the stomach of a suitable host, the young worm resumes its feeding which had been interrupted during the last stage. It grows to about .66 mm. by 25μ, its mouth turns slightly dorsad, and two pairs of teeth, dorsal and ventral, appear. Buccal capsule and digestive system become better developed, and the male and female sexual organs begin to form in different individuals. About fourteen days after they have entered the intestine, having attained about 2 mm. long by 12 to 14μ broad, they pass through the last moulting and assume the characters though not yet the size of the mature worm.

Sources of Infection. These are infested fields and waters. Pastures that have been grazed year after year by sheep harboring this worm, feeding yards where the surface and troughs are contaminated by the sheep droppings and young worms, pools, streams or open wells into which these have found their way, streams that have flowed through infested pastures higher up, fields that receive the drainage of higher infested pastures during wet weather, swamps and springy places that preserve and develop the parasite out of the body and in which the vegetation is easily torn up by the roots with infested mud adherent, feeding salt or meal from the bare ground to be licked by the sheep, soiling on cultivated fodders in wet weather, salt or alkaline licks including dried up liquid manure, all tend to the introduction of the parasite into the system. They also enter by direct penetration of the skin.

Symptoms. Beyond unthriftiness, loss of condition, loss of the sub-cutaneous fat, weak flaccid muscles, uncertain swaying gait,

blanched mucosæ, and anæmia, little has been noted as the result of sheep uncinariasis. It cannot be doubted, however, that the long list of evils, which attend on infestment by hookworms in man could be noted also in different cases in the sheep. The alternate constipations and diarrhœas, the cardiac palpitations and anæmic murmurs, the intermaxillary, subventral, pleural and peritoneal dropsies which attend on other sheep parasitisms, may well be looked for in different cases. The discovery of the worms and especially of their transparent eggs by washing the fæces must after all be looked upon as the conclusive evidence (see under U. Radiata). That the worm sometimes exists without serious resultant trouble being recognized is to be accepted, but when this is joined to conditions favorable to its encrease, like, a genial climate, absence of frosts, a damp soil, and a heavy stocking of the same land with sheep year after year, a parasite with the deadly potencies of the uncinaria cannot fail to cause a destructive enzoötic.

Treatment. The agents most in use in uncinariasis are thymol and male fern. The great drawback as in all ruminants is the delay of the agent in the first three stomachs, and the loss and dilution of the agent through absorption and diffusion through the great mass of ingesta. Stiles, however, claims excellent results with 32 to 60 grains of thymol given at one dose without a purge. The main objection to thymol is its expense when demanded for large flocks. Gasoline another volatile and diffusible vermifuge can be tried. Or areca nut with arsenious acid may be resorted to in anæmic or weakened conditions. Or finally any one of the vermifuges advised for Strongyli may be resorted to. In any case they are best given in the morning before the first feed, after a purgative the night before, and should be followed by a purgative later in the day. It is further important to give water largely with or after the dose to hasten the progress of the latter through the gastric cavities. A generous diet and tonics are important in sustaining the system through an attack. (See under Distomatosis.)

Prevention. This is the most important as it can be made the most successful factor in treatment.

In districts and flocks free from uncinaria great care should be taken to exclude animals from infested flocks and districts.

Sheep of uncertain antecedents should be thoroughly examined, and kept in quarantine until proved to be sound.

Sound flocks should be carefully kept from pastures that receive the drainage of areas grazed by other (suspected or uncertain) flocks, and from streams that have flowed through such areas.

An infested flock should be treated (preferably in winter) for the expulsion of the worms and then turned out on newly seeded pasture, the soil of which has not recently been manured with the products of sheep folds, and the drainage and water supply of which are above suspicion.

Ewes should be kept on a limited area until after lambing, and the expulsion of their worms, and should then be turned with their lambs upon a freshly seeded pasture, which has no other source of contamination.

Young and non-breeding sheep should be similarly treated with vermifuges before being turned out in spring, and should have newly seeded pastures each year. Grass should be made to alternate with other (cultivated) crops, or better with a rotation of cultivated crops so that the worms and ova in the soil will be destroyed by the lack of the necessary ovine hosts.

When a pasture is unsuited for cultivation, all sheep and goats should be kept off it for one or even two years, and cattle or horses turned on in place.

All springy parts of lands previously occupied by infested sheep should be securely fenced against encroachment by flocks.

All pools and lakes and all shallow open wells on such lands and all rivers that receive drainage from infested or suspected areas should be similarly fenced against the access of sheep. The supply of water from deep springs or wells, the latter well secured by cement against surface leakage, is essential.

When sheep must be turned on infested pastures, or must mingle with infested or suspected animals, as lambs with ewes or older sheep, they should be kept in folds or on clean pasture in early morning or in wet weather so long as there is danger of the vegetation being torn up by the roots.

No salt nor other food should be thrown down to be eaten from the ground. A liberal supply of salt in troughs, and, moderately, in drinking water, is very important.

As in all other dangerous parasites flock-masters who allow sheep infested with uncinaria to occupy pastures or folds on the

line of running streams, or on higher lands that drain over the lower lands of a neighbor, should be held guilty of a misdemeanor, subjected to a penalty, and compelled to abate the nuisance. The sale of such sheep without certifying the purchaser of their condition should also subject him to suit for damages.

Sclerostoma Hypostomum (hypo-beneath). Body white, cylindroid, rigid. Head bent ventrad. Mouth round, opening downward, with six papillæ and a double row of sharp teeth. Buccal cavity with longitudinal chitinous ribs converging to the round œsophagean orifice. *Male* 10 to 20 mm. long, 2 spicula, long, curved, transversely striated, with sharp edges, and bursa narrow, bell-shaped. *Female* 13 to 24 mm. long, thick, to the caudal extremity which, however, terminates in a sharp point, curving upward. Vulva in front of the anus, yet very near the tail, and surrounded by a yellowish brown encrustation. *Ova* elliptical.

Habitat. Large intestine and ileum of sheep, goat, chamois, roe buck, argali, etc. Common in some localities. The ova pass out with the manure in which they hatch and the embryos survive without material growth for months. They also live almost indefinitely in water. Taken in by the sheep they develop into the mature worm. Baillet suspects that they pass the state of larva (sexually immature) in cysts of the intestinal mucosa, after the manner of the sclerostoma tetracanthum, but this has not been demonstrated.

Pathogenesis. Like other blood sucking worms they make numerous wounds of the mucosa and by this as well as the abstraction of blood, lead to local congestions, catarrhs, anæmia and emaciation.

Prevention and treatment are essentially as for strongyli and uncinaria.

Trichocephalus Affinis. This worm has already been described as a parasite of the ox. It is much more common and injurious in sheep, producing intestinal catarrhs and congestions, with diarrhœa. The treatment is the same as for other blood sucking worms.

Strongyloides Ovis. Anguillula. Rhabdonema Longus. The *Strongyloides of the sheep* (6 mm. long) is much larger than that of man (2.2 mm. long) implying a difference in species.

Leuckart found that they could attain sexual maturity either in the intestines or in rich moist earth outside, and he concluded that the external habitat was but another stage of the life-cycle, essential to a new internal habitat. The mouth is triangular with three prominent lips (less pronounced in the external habitat) The transverse striæ on the skin are also much less marked in the nonparasitic form. The males, much smaller than the females, have the tail rolled up and two spicula. The female is straight with pointed tail and vulva on ventral aspect behind the middle of the body. Eggs, ovoid .05 to .07 mm. in their long diameter, and from 30 to 40 in number at one laying.

Habitat. They are found in the intestines (and exceptionally in the bile and pancreatic ducts) and the ova and embryos, carried out, must develop to the condition of ensheathed larvæ, before they can take up a new internal habitat. In experiments made at the B. A. I. Station at Bethesda, Md., the eggs from a sheep, hatched out in 1 day in a culture of the fæces in a covered glass vessel, yet the growing larvæ were three days before they were advanced enough to survive when *fed* to a rabbit, or *placed upon its skin* under a moist dressing. By the last method the larva enters a cutaneous gland duct and then the lymph and blood channels, and, finally, the intestines.

At ordinary room temperature the larvæ in fæces reach the infesting stage in 3 to 7 days, and when introduced into the rabbit through the stomach or skin they attain sexual maturity in one month.

Pathogenesis. Grave symptoms have not been noticed, probably largely on account of the infrequency of the invasion. But in gravely infested subjects, in some of which 1,000,000 ova and embryos may be passed daily, and in view of the fact that the larvæ enter through the skin and vessels as well as by the stomach, they cannot fail to be seriously injurious. Each worm too may be the bearer of microbian germs, from which flocks suffer so extensively. On the other hand the local conditions which favor the propagation and introduction of other destructive parasites as well, and hence the eel-worm is usually but an accessory to the more destructive parasites such as the contortus, filicollis, uncinaria, œsophagostoma, tænia, distoma, etc. Every precaution should therefore be taken to prevent the introduction of infested

sheep or rabbits, and to seclude flocks from ground that has already become infested. The measures already advised against lung worms and other intestinal worms will be largely applicable here.

INTESTINAL PARASITES IN THE GOAT.

These are almost identical with those of the sheep. It harbors the **Tænia Expansa, Strongylus Filicollis, Œsophagostoma Venulosum, Sclerostoma Hypostomum Uncinaria Cernua,** and **Trichocephalus Affinis.**

INTESTINAL PARASITES IN SWINE.

Balantidium coli, a ciliated infusorian with rapid movements, terminal mouth. Seem harmless to swine, though smaller form hurtful to man. *Trichomonas Intestinalis*, an infusorian with 4 or 5 anterior flagellæ; seems harmless. *Cestodes; Trematodes; Echinorhynchus Gigas:* Narrowed to tail; protractile proboscis with recurved hooks, which it sinks in mucosa. *Ovum* passed in fæces, swallowed by larva of May beetle, the cockchafer, or a snail, helix pomatia, helix hortensis, limax maximus, arion rufus; these are eaten by the pig and the parasite matures in its small intestine. Found with hooked proboscis in mucosa; common in herds in fields; Europe, America. Cause nodules, pits, congestions, infections, colics, etc. *Treatment:* Vermifuges. *Prevention:* Keep in-doors, or in pens, away from infected invertebrates. *Ascaris Suilla:* Like ascaris of man; in small intestines, stomach, gall-ducts. Causes indigestion, colic, emaciation, vomiting, watery diarrhœa, obstructed bowels, biliousness, jaundice, stupor, vertigo. *Treatment, Prevention. Œsophagostoma Dentatum:* Narrowed ends, wide mouth with six papillæ and bristles; in large and small intestines of pigs and pecari; treat by vermifuges. *Globocephalus Longimucronatus:* 7 to 8 mm. long; in small intestine; pig. *Trichocephalus Crenatus:* Held identical with whip-worm of man; spiculum more spinous; in large intestine; head and neck buried in mucosa. May cause a plague, indigestion, colic, diarrhœa, emaciation; treat by vermifuges. *Trichina Spiralis:* Mature in intestines. *Anguillula Suis:* Apparently harmless.

PROTOZOA. The one protozoan which has been recognized in the intestines of the pig and which is pathogenic (at least to man) is the Balantidium Coli.

Balantidium Coli (balantidion a little pouch). Paramœcium Coli. A ciliated infusorian parasite 70μ to 100μ long by 50μ to 70μ broad. It is an ovoid organism, with terminal mouth, and

completely covered by fine short cilia by which it effects rapid movements. The delicate external membrane is striated longitudinally, and the central granular matter and protoplasm contain an ovoid nucleus and several contractile vesicles. Reproduction may follow the conjugation of two individuals and occurs by transverse fission.

Leuckart (1863) found this in the colon and rectum of pigs in Saxony, and since then it has been proved to be common in Sweden, Russia, Paris and Toulouse. By the aid of a hand lens the infusoria are seen as minute white spots moving in the mucus and feculent matters drawn from the rectum.

When dropped in water they move freely at first, but soon become motionless, loose their cilia (first the short, then the oral), and contract into spherical bodies. In this condition, as well as when dried in the fæces, they are very tenacious of life, and find their way into the alimentary canal of a fresh host through the food and water.

Pathogenesis. They have not been observed to prove hurtful to swine, but in man they cause severe indigestion and profuse and obstinate diarrhœa. Wising finds the parasite much smaller in man, while Calandruccio and Grassi failed to produce the disease in man by feeding the parasite of the pig. Unless the two are specifically distinct the protection of man would require their destruction in swine.

Trichomonas Intestinalis. Like other trichomonas this infusorian has four or five anterior flagella, one of which is directed backward and projects beyong the caudal end of the body. It has been found by Kunstler in the intestine of swine, but appears to be much more common in man. No *pathogenesis* has been observed.

CESTODES.

No adult cestode is known to infest the intestine of swine. The tænia solium which exists in the human subject in both the mature and larval forms is found only in the latter form as the cysticercus cellulosa in the muscles and connective tissue of the pig. Tardieu claims that he saw portions of a tænia passed by a pig, but no such occurrence has been noted by any other observer.

TREMATODES.

Distoma hepaticum and distoma lanceolatum both live in the gall ducts of swine, and will exceptionally escape into the small intestine and be found there. The ova must pass through the bowel to reach their succeeding stage of development in fresh water and the cercaria to reach the liver.

ACANTHOCEPHALA.

Echinorhynchus gigas. (**Gigantorhynchus gigas**). This is a cylindroid worm sometimes slightly thickened at intervals and always greatly attenuated toward its caudal end. The anterior extremity bears a protractile proboscis, globular or conoid, and covered by a large number of recurved hooklets, which arrangement gives the parasite its name (echinos hook, thorn). The *male* is 2 to 3 inches long by 3 to 5 mm. thick, with caudal membranous expansion around the genital orifice. The *female* may be 7 to 11 inches long, thicker than the male and with blunt caudal end. *Ovum* forms an elongated ellipsis, and has three transparent coats through which, in a few days after laying, the *embryo* can be seen as an elongated cone with four hooklets on the cephalic end.

Development and Metamorphosis. The ova, laid in the intestine of the pig, escape with the fæces and are swallowed by the larvæ of the May beetle (Melolontha Vulgaris, Schneider), or by gasteropod molluscs (Helix pomatia, H. hortensis, Limax maximus, Arion rufus) as in the experiments of Lespès. The latter found embryos in the intestines of the molluscs and a developing larva in the liver of Helix. Kaiser found that the egg was swallowed by the rose cockchafer (Cetonia aurata), and the hatched embryo bored its way from the stomach to the subcuticular muscular layer in which it encysted itself. It seems probable that the larval stage may be passed through in a variety of invertebrates, which are in turn devoured by the pig and the larva is set free to attain its mature development.

Habitat of mature echinorhynchus. It has been found in the small intestines of swine with its protractile proboscis deeply buried and fixed by its hooks on the mucous membrane, and its caudal end floating distal from the stomach. They are not rare in Germany, France, Austria, and America, and tend to abound

especially where hogs have a wide range and every facility for feeding on invertebrates.

Pathogenesis. The anchorage by the hooked proboscis of the worm in the mucous membrane gives rise to the formation of small congested papules on a white ground, with a central depression or sore in case the worm has let go its hold. The papules may be the size of a hempseed or larger and are often complicated by minute abscesses scarcely larger. The perforations, usually inconsiderable, will in exceptional cases, extend through the mucosa, the muscles and even the serosa and give rise to infective peritonitis. The mucosa may show numerous small cicatrices, on a bluish gray ground.

Symptoms. These are as with other intestinal worms : irregular appetite, constipation alternating with diarrhœa, much discomfort, grunting and squealing before meals, restlessness and irritability, burrowing under the litter and rising and moving about without apparent cause, progressive emaciation, convulsions and epileptic attacks, vomiting, and the presence in the fæces of the elongated elliptical ova. The attack of a number of swine in the same herd or locality may well arouse suspicion. Young pigs may die in three or four days. D'Arboval notes stiffness and weakness of the hind parts, but this is much more likely to occur in Strongylus gigas, or Stephanurus dentatus.

Treatment. Little has been done in the way of treatment, but the ordinary vermifuges for intestinal worms may be confidently resorted to. By way of prevention in infested localities, pigs should be rigidly shut up in doors and their manure burned or saturated with mercuric chloride solution to destroy the embryo as soon as hatched. In this way the cycle of development will be broken, the invertebrates will fail to obtain the ova and embryos, and the pigs will fail to find invertebrates which harbor the larva. Under these conditions the parasite must necessarily be banished from the locality. It will be necessary of course to have municipal or county regulations which forbid the turning out of pigs to roam at large.

In Meaux, France, destruction of the May beetle has been actively conducted, 470,000,000 having been killed in 7 years. Counting 40 larvæ for each female this represented 9,400,000,000. Each grub creating a loss of 1 centime ($\frac{1}{5}$ cent), this saves

$19,000,000 without counting the yearly encrease in the absence of such precautions. The May beetle has a life cycle of 3 years and must be assiduously combatted in years when it is especially plĕntiful.

NEMATODES.

Ascaris Suilla: Duj.

In size and general appearance this closely resembles the Ascaris lumbricoides of man with which it has been held to be identical (Leuckart, Schneider). The *male* is 15 to 17 cm. long and 3 mm. thick; the *female* about 20 to 25 cm. long and 5 mm. thick. The body is white, firm, attenuated at both ends, and the skin is marked by longitudinal striæ which are closer to each other than in ascaris lumbricoides of man. The spicula are flatter and blunter, the oviducts more convoluted and the ova smaller. The mouth is terminal, triangular, with three projecting lips bearing papillæ at their base. The caudal portion of the *male* bears 68 to 75 papillæ.

Habitat. The usual habitat is the small intestine, though sometimes it has been found in the stomach and we have frequently seen it in the gall ducts.

Pathogenesis. When in small numbers they do little harm, but where pigs are kept continuously in herds on the same ground, or when they drink water which has drained from other pig pens or yards, they often appear in great numbers and produce serious intestinal disorder, indigestion, emaciation, colics, vomiting, obstructions of the bowels and watery diarrhœa. When it invades the gall ducts or pancreatic ducts, serious hepatic disease, with stupor, giddiness or jaundice may ensue, or imperfect digestion of fats and albuminoids may come from the pancreatic obstruction.

Treatment and *prevention* will be essentially the same as for other nematoid worms.

Œsophagostoma Dentatum. Rud. **Œs. Subulatum.** Molin. **Strongylus Dentatus.** Rud. **Sclerostoma D.** Dies. This is a small worm having a length of from 8 mm. (male), to 15 mm. (female), narrowed at both ends, with wide circular mouth and œsophagus, the former bounded by two ridges of which the inner horny one bears a row of bristles, and the latter six pointed papillæ. Two other papillæ project in the œsophagus, which ends in a pear-shaped dilatation and wide intestine.

Male with a bell-shaped caudal bursa and two delicate spicula. *Female* with a finely attenuated and sharply pointed tail. The ovaries extend from beneath the œsophagus to the tail and the vulva is 0.59 to 0.65 mm. in front of the extremity. Eggs ovoid 0.06 to 0.08 mm. in the long diameter.

They are found in the large intestine of swine and the white-lipped pecari. Baillet has found them in the small intestine. They are not usually present in great numbers and consequently rarely do much damage. Any irritation caused by great numbers must be met by vermifuges as in the case of other intestinal worms.

Globocephalus Longimucronatus. Mol. This small worm 7 mm. long (male), 8 mm. long (female), the male having a three-lobed caudal membrane with its posterior ribs trifid, and its middle ones bifid, and covering two spicula, was found by Wedl in the small intestine of a pig. It must be looked upon as rare and so far as known comparatively harmless.

Trichocephalus Crenatus. (*Dispar?* Rud.). *Whipworm of Swine.* This resembles closely the whipworm of man and has been supposed identical. It differs in the sheath of the spiculum which is covered by short blunt spines that are especially numerous anteriorly. The spiculum is rounded and blunt. The *male* is 40 mm. long and the *female* 45 mm. of which ⅔ds constitute the thread-like cephalic portion. They are oviparous, and the spherical ova, hatch out in water or damp earth or other media, and being swallowed in water or food, develop directly into the mature worm (Leuckart).

Habitat. Pathogenesis. These worms inhabit the large intestine, mainly the cæcum, and are found with head and neck deeply buried in the mucosa for the purpose of sucking blood or plasma. When present in small numbers only, they are comparatively harmless, but in large herds, on damp yards, or drinking infested water, they may be found in large numbers and cause diarrhœa, indigestions, colics and unthrift. They are to be treated like other intestinal nematoids.

Trichina Spiralis. (Owen). All forms of the trichina are found in the bowels of swine :—the embryo introduced in water or just produced by the mature female worm :—the larvæ or encysted worm introduced with trichinous meat, or free after the meat and cyst have been digested :—and the sexually mature in-

testinal trichina. The two former are, however, only transitory guests as they speedily bore their way through the walls of the bowels to encyst themselves in the voluntary muscles, while the mature parasite spends the full measure of its existence in the bowels and fulfills its destiny in propagating its kind. (See under *Muscular Parasites*).

Strongyloides (Anguillula) Suis. Rhabdonema Suis (Lutz). Like the anguillula of man, this is smaller than that of the ruminant. Lutz claims that it can only be hatched outside the body, unlike that of man which can be hatched in the intestine. He further claims that in Brazil where the anguillula of man abounds, that of the pig is rare, though hogs run at large and have every opportunity of devouring human fæces and the water that drains from them. They are not known to prove injurious to pigs, probably because of their infrequency.

INTESTINAL PARASITES OF THE DOG.

Lamblia Intestinalis: Coccidium Perforans in intestinal epithelium, causes local inflammation, indigestion, anorexia, colic, diarrhœa, nervous symptoms, emaciation. *Coccidium Bigeminum* in pairs in villi of small intestine. *Cestodes:* Table of tape-worms of dog. *T. Serrata*, from preying on rabbits and hares; 20 to 60 inches; armed protractile proboscis, 34 to 38 hooks; larva *cysticercus pisiformis* in peritoneum, etc., of rabbit which eats grass or drinks water having the eggs. *T. Serialis:* Small intestine, from preying on rabbits; 15 to 25 inches long; protractile proboscis armed with hooks, 26 to 32, each with handle as long as blade, guard slightly bifid; ripe segments three times as long as broad; larva *Cœnurus serialis* encysted in connective tissue, nerve centres and other viscera of rabbit, each cyst having 100 or 200 heads, one inch or more in diameter. *T. Marginata*, in small intestines of butchers' dogs; head small, proboscis with 30 to 44 hooks in two rows, handle bent backward, guard undivided. Larva *cysticercus tenuicollis:* Diving bladder worm, elliptical, 1 to 1½ inch; in peritoneum of ruminants and pig. Little harm unless a whole ripe proglottis is swallowed by lamb. *T. Cœnurus:* Common in small intestines of dog, fox and wolf, in sheep districts; armed proboscis, 22 to 32 hooks; in smaller row handle exceeds blades; length of ripe segments thrice the breadth; larva *Cœnurus cerebralis* as cyst in brain or cervical cord in sheep, each cyst with 100 or 200 heads. *Symptoms* of cyst: Timidity, nervousness, dulness, stupidity, dilated pupils, drooping lids, mopes apart, restless movement in one direction, to left, right, or right ahead; if in cord, motor palsy on one

side and sensory on other, remissions; attacks lambs and yearlings, the weak; bone softening. *Prevention:* Keep dogs from pastures; feed mutton products to dogs, only after boiling; boil, burn, or deeply bury carcases, especially heads of infested sheep. Feed flock generously; kill affected fat lambs for mutton. *Treatment:* Trephine; extract cyst. *T. Echinococcus:* ¼ inch long, 4 segments, one ripe, armed proboscis, 28 to 50 hooks; in small intestines; dog, wolf; cause digestive disorder, convulsions, delirium. Larva *Echinococcus* in liver or serosa, or viscus of man, ape, ruminant, horse, elephant, pig, rabbit, turkey, etc. Cysts can develop one head, or daughter and grand-daughter cysts, with or without heads, thus multiplying numbers in cystic stage till cluster is inches in diameter, acephalocysts and scolices. Clusters of minute cysts, E. Multilocularis. Longevity of cyst great; pathogenesis according to organ invaded; infested liver up to 158 pounds. *Symptoms:* Respiratory trouble with little hyperthermia and no response to tuberculin; or jaundice without fever, or biliary or renal colic, with uræmia and dropsy; or in superficial cysts, fluctuation, thrill, saline liquid containing hooklets; frequency in different organs. *Distribution:* In Iceland, Mecklenbrug, Prussia, India, Siberia, Abyssinia, Australia. *Treatment:* Electricity, evacuation and iodine injection. *Prevention:* Kill useless dogs, allow dogs no raw meat, destroy tænia in dogs, exclude dogs from wells and drinking water, sterilize dog's dung, filter all drinking water drawn from shallow wells. *T. Canina:* 3 to 14 inches long; protractile, armed, club-shaped proboscis with four rows hooklets; segments like melon seeds; in small intestine; dog. *Cryptocystis trichodectis:* The larval form in abdomen of dog-louse or flea. *Treatment:* Tæniacides and phthiriacides. *T. Litterata:* Globular head without hooklets or proboscis; genital pore on middle of ventral surface, and genital organs small as in bothriocephalus; in small intestine; dog; Iceland, Europe. *Bothriocephalus latus:* 25 feet long by one inch; head flat, lateral pits, no hooklets nor proboscis; sexual pores in middle of flat ventral surface; caudal segments shrink before they drop off, after eggs are laid. In intestine of man, dog and cat; fish-eaters, on shores of seas and lakes. *Larva, Plerocercoides:* In intestinal walls, muscles, etc., of pike and turbot, tench, grayling, perch, etc. *B. Cordatus:* 2½ to 4 feet long, 400 to 600 segments, head flat heart-shaped; lateral bothridia, genital pore in centre of ventral surface; in dogs and man in Greenland. *B. Fuscus:* 3 to 27 inches long; oviducts as dark blue spot in centre of segment. *B. Reticulatus; B. Dubius:* Allied forms in Iceland. *Treatment:* Tæniacides. *Prevention:* Cook all fish fed; exclude dogs receiving raw fish.

INFUSORIA.

Lamblia Intestinales, (Blanch.), infests the dog in common with the human being, sheep, rats and mice. It is pyriform 9 to 16μ long by 4 to 7μ broad, and has four pairs of flagella attached to the border of a large sucker. It is not especially injurious.

Coccidium Perforans. This sporozoön is harbored in the

intestinal epithelium of man, dog, rabbit, cat and hen. It is distinguished from the *Coccidium Oviforme* by its parasitism in the bowels rather than the bile ducts, and by a shorter period of evolution outside the animal body (Leuckart). The parasite will be more fully considered under coccidiosis of the rabbit.

They cause swelling and clouding of the epithelium, with aggregation tending to form white points, and finally desquamation. Local inflammation with anorexia, indigestion, colic, diarrhœa, with nervous (rabiform) symptoms and emaciation.

Coccidium Bigeminum. Styles gives this name to a coccidium which occurs in pairs in the villi of the small intestine of the dog. They vary in diameter from 7μ to 16μ, and each contains four fusiform spores. No distinct pathogenesis has been traced to them.

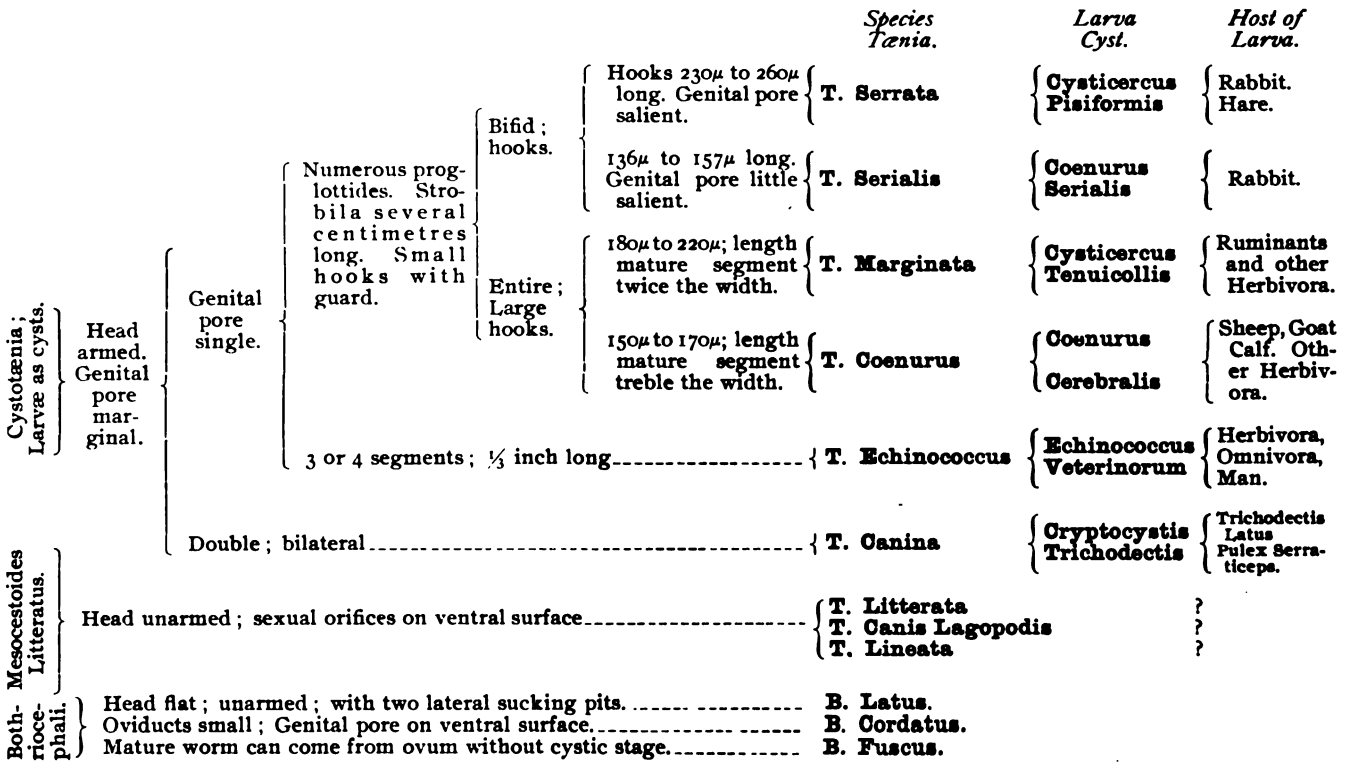
CESTODES. TAPEWORMS.

Like all carnivora, the dog is very subject to tapeworms, and especially harbors them in the mature (tænia) form in the intestines. The cystoido-tæniæ which live in another host in their cystic or bladderworm stage, are derived usually from the herbivorous animals on which the dog preys.

The tænia of the dog may be tabulated and in the main differentiated by the following table on next page.

Tænia Serrata. Serrated tape-worm. This inhabits the small intestine of the dog which obtains it by eating rabbits and hares. When discharging ripe segments it may measure from 20 to 60 inches—usually 40 inches. Head is slightly broader than the neck, tetragonal with a sucker on each angle. Proboscis retractile with two rows of 34 to 38 hooks, one row long (230μ to 260μ) and one short (125μ to 160μ), and each bearing a process or guard. Segments at neck mere transverse lines; caudal segments 3 times as long as broad (5 by 15 mm.). Genital orifice on projecting marginal elevation. Oviducts lengthy, branched (8 or 10). Ova slightly ovoid.

The **cysticercus pisiformis**, the larval form, is found in the peritoneum of rabbits and hares, the cyst having a variable size, on an average about ½ inch and containing the head and neck of the tænia, which is withdrawn into the sack through an orifice in its wall, as a finger of a glove within itself. By feeding a ripe


Species Tænia.
Larva Cyst.
Host of Larva.
Cystotænia; Larvæ as cysts.
Head armed. Genital pore marginal.
Genital pore single.
Numerous proglottides. Strobila several centimetres long. Small hooks with guard.
Bifid; hooks.
Hooks 230μ to 260μ long. Genital pore salient.
T. Serrata
Cysticercus Pisiformis
Rabbit. Hare.
136μ to 157μ long. Genital pore little salient.
T. Serialis
Coenurus Serialis
Rabbit.
Entire; Large hooks.
180μ to 220μ; length mature segment twice the width.
T. Marginata
Cysticercus Tenuicollis
Ruminants and other Herbivora.
150μ to 170μ; length mature segment treble the width.
T. Coenurus
Coenurus Cerebralis
Sheep, Goat Calf. Other Herbivora.
3 or 4 segments; ⅓ inch long
T. Echinococcus
Echinococcus Veterinorum
Herbivora, Omnivora, Man.
Double; bilateral
T. Canina
Cryptocystis Trichodectis
Trichodectis Latus Pulex Serraticeps.
Mesocestoides Litteratus.
Head unarmed; sexual orifices on ventral surface
T. Litterata ?
T. Canis Lagopodis ?
T. Lineata ?
Bothriocephali.
Head flat; unarmed; with two lateral sucking pits.
B. Latus.
Oviducts small; Genital pore on ventral surface.
B. Cordatus.
Mature worm can come from ovum without cystic stage.
B. Fuscus.

segment of the T. serrata to a rabbit these are developed in the liver, in which, in fifteen or twenty days they may be found as small, white, worm-like bodies 1 to 4 mm. in length. These proscolices mostly migrate into the peritoneum and are found attached to the viscera, the parietes, the mesentery or omentum as scolices. The rodent host, being devoured by the dog, they develop in his intestines into strobila by dropping the caudal cyst. In 50 days these may be 5 to 8 inches in length; in 60 days about 20 inches; in 150 days from 4 to 5 feet and shedding ripe segments. The rabbit is usually infested by eating vegetation or drinking water which contains the proglottis or ova derived from the dog's fæces. The cysticercus has great vitality and though dried up in the tissues, it will show active vitality if put in tepid water.

Tænia Serialis: inhabits the small intestine of the dog, but is much more rare than the tænia serrata. It may attain a length of 15 to 25 inches. Head a little wider than the neck; tetragonal with 4 discs, and protractile proboscis with 26 to 32 hooks, each furnished with a guard and having the handle as long as the blade. Guard slightly bifid. The ripe segments are three times as long as wide (4 by 12 mm.). Genital orifice marginal, projecting. Ova nearly round (34μ by 27μ). In its general characters the worm resembles its near relative the *tænia cœnurus*.

Cœnurus Serialis, the larva or scolex of the *tænia serialis*, is found in the connective tissue of various internal organs, including the spinal canal of the rabbit. It may grow to the size of a hen's egg, and contains 100 or 200 heads of the tænia in a single sac.

Tænia Marginata (Batsch). This inhabits the small intestine of the dog, and is less common than tænia serrata as the hosts of the scolex (cysticercus tenuicollis), the ruminants, are less frequently devoured raw by the dog than are rabbits. Dogs kept about slaughter houses are especially liable to suffer.

The head is as narrow as the neck, or nearly so, and for some distance the segments are marked only by transverse striæ, yet the mature caudal segments are twice as long as they are wide (7 mm. by 15 mm.). The proboscis is furnished with a double row of hooks (130μ and 200μ), 30 to 44 in number, each handle being curved in a direction contrary to the blade, and the guard

undivided. The genital pore is marginal and slightly projecting; the oviducts divided in 12 or 16 branches; the ovum round (33μ).

Cysticercus Tenuicollis *narrow-necked cysticercus*, the larva or scolex of tænia marginata, is found very frequently in the peritoneum of the domestic ruminants, and less so in the pig, or in the pleura of ruminants. The cyst is elliptical, and may be 1 to 1½ inch in diameter. At the free end is the orifice through which the scolex is invaginated, and if the whole is placed in milk-warm water the head may be seen to rise and fall in the sac, whence the name of *diving bladder worm*. If a lamb is fed some ripe segments of the tænia marginata, it may die in 6 days with the liver studded throughout its substance with little blood clots each containing one or more of the transparent hooked embryo or proscolex. By the 10th day some may be found in the peritoneum and by the 25th day these may be in certain cases 1 cm. long. In 40 days they have been found 2½ cm. long and with well developed head. In 250 days they have attained their full size as larvæ.

Pathogenesis. As taken in casually, one or two ova at a time, this parasite has never been known to prove appreciably injurious to ruminants. It is only when one or more ripe proglottides have been administered or swallowed accidentally that a serious lesion such as hepatitis or peritonitis has ensued.

Tænia Cœnurus (Kuch.). This parasite lives in the small intestine of dog, fox and wolf, and is often quite common in sheep-breeding districts, the larva or scolex having its habitat in the brain or spinal cord of lambs or yearling sheep, and less frequently in the young of other ruminants. When mature and discharging ripe segments the tænia may measure 40 inches long. The tetragonal head is followed by an attenuated neck with scarcely a sign of segmentation, yet the caudal, ripe segments attain a length of three times their width (5 mm. by 18 mm.). The proboscis bears a double row of 22 to 32 hooks, 100μ to 160μ long. The handle of the longer hooks just exceeds the blade in length, while in the smaller hooks it is decidedly longer than the blade. The oviducts have numerous branches running mainly parallel to the length of the segment. Genital pore, marginal, dilated, slightly projecting. Ova nearly spherical, 34μ with transparent envelope.

Cœnurus Cerebrales (Kuch.). The larva of T. Cœnurus inhabits the cerebro-spinal cavity of lambs, yearling sheep and exceptionally other domestic ruminants and horses, and still more so in dogs, causing the disease known as "gid," "turnsick" or "waterbrain." As in the case of Cœnurus Serialis, the ovum from the ripe segment in the dog's fæces, having hatched out the six-hooked embryo, the latter migrates to its suitable habitat and there develops into a cyst which may exceed a hen's egg in size. This parent cyst develops scolices to the number of 100 to 200 which are individually little larger than a millet seed. but each shows the head of a future tape-worm, and matures as such if the brain which harbors it is eaten by a dog. **The development** is slow. In two lambs fed proglottides by Baillet, the symptoms of "gid" appeared in one on the 68th and in the other on the 114th day, yet the one showed at the necropsy 33, and the other five cœnuri in different stages of development.

On the eighth day after feeding proglottis, points of congestion are observed in the brain. From the fourteenth to the thirty-eighth day the surface of the brain is marked by pale, yellowish tortuous canals, and near the end of each a cyst $\frac{1}{10}$ inch in diameter. By the thirty-eighth day the cyst may be as large as a cherry, and minute depressions on its surface mark the first step toward the formation of the heads of the scolex. By the fifty-second day sucking discs and hooklets may be visible. After 2½ to 5½ months the scolex is viable in the intestine of the dog. (Kuchenmeister).

Transmission from the sheep to the dog will sometimes fail through diarrhœa in experimental cases. As many as 400 tænia have been developed from one cyst. They attain a length of four inches in four weeks. The writer raised forty-two, averaging one foot, in six weeks in a sucking puppy.

The *Symptoms* of tænia cœnurus in the dog are the same as of other tape-worms. The ripe segments passed are characteristic.

Symptoms of Cœnurus Cerebralis: Cœnurosis Cerebrale: Gid: Sturdy: Staggers: Turnsick: Waterbrain. The signs of cerebral congestion (dulness, red eyes, hot head, drooping or held in one direction, spasms or paralysis) may appear in eight days after a lamb or calf has been fed a ripe segment of the tape-worm, but usually but one, two or three ova

are taken in with the grass, and suppose all reach the brain, they are unable to produce these early manifestations. In an experimental case with five cerebral cœnuri the first symptoms were observed on the 114th day, (Baillet).

The symptoms are, at first, great timidity and nervousness without apparent cause, or dulness, stupor, general aberration of the senses and disorderly muscular movements. The sheep is found apart from the flock with dilated pupils, blindness, reddened eyes covered with half-closed lids, and unsteady gait, but usually moving restlessly in one given direction. Alternate subsidence and exacerbation of symptoms are not uncommon, the latter corresponding to the occasions on which the heads of the scolices are protruded into the brain substance, the former to their periods of withdrawal within the cyst.

The symptoms vary according to the position and number of the hydatids. If in the usual position, in one hemisphere, and over the lateral ventricle, the lamb turns to that side, moving in a circle, like a horse in a mill, making a bare beaten circular path. The limbs on the opposite side of the body act in a stiff disorderly manner, being paretic. If a cœnurus exists in each hemisphere the lamb turns to that side on which the irritation is greatest at the time, going to the left at one time and to the right at another. When it is directly in the median line, over the corpus calosum the sheep elevates its nose and advances straight forward until arrested by some obstacle. If lodged in the cerebellum it causes elevation of the head, sudden jerking upward of the limbs, planting them with a hesitating uncertain motion, great nervousness, and sometimes a stumbling run, followed by a fall, and violent ineffectual struggles to get up. Blindness is usually present, but especially so, if there is pressure on the optic thalamus, corpus striatum or corpora quadrigemini. If the cyst is located in the upper part of the spinal cord there is motor paralysis on the same side of the body and sensory paralysis on the opposite side, behind the hydatid. There may be palsy of both hind limbs, rectum, bladder and tail. Sometimes there is intense itching along the spine.

In all cases there is a hesitancy and uncertainty of movement. The remissions serve to distinguish the affection from paresis or cerebral disorder due to a simple tumor like a cholesteatoma or psammoma.

If left to itself the patient neglects tc eat and by the combined starvation and constant movement it rapidly wastes and dies in marasmus. If well fed and cared for it may sometimes gain flesh.

The cœnurus usually affects lambs, and rarely sheep of over two years old, or those that are strong, vigorous and well conditioned. The young, thin, weak and starved are the main victims. For the same reason those on poor, damp, exposed ground suffer more than those on rich, dry, sheltered pasture.

Exceptionally in old standing cases, with the hydatid near the surface of the hemisphere, the cranial bone is absorbed and a soft spot may be felt indicating the seat of the parasite.

Prevention. Destroy superfluous dogs. Deny to dogs all parts of the body of the sheep which has suffered from this disease. The sheep heads especially must be boiled, rendered, burned or deeply buried. Never allow them to be thrown, raw, where dogs, foxes or wolves can find them. Let necessary dogs be frequently examined and all tapeworms expelled by vermifuges. Allow no untreated dogs on the pasturages of young sheep, nor about the sources of their water supply. Keep all young sheep in a constantly thriving condition. If any have shown the early symptoms of cerebral congestion and have survived them, fatten and kill as soon as the secondary symptoms commence—about the end of the third or the middle of the fourth month. Damp pastures should be drained and exposed ones sheltered.

Treatment. In rare cases a spontaneous recovery may ensue in connection with rupture of the scolex from a sudden fall or a blow on the head. Hogg attained the same end by puncturing the cyst with a common knitting needle, introduced through the nose and perforated plate. Youatt passed a long trochar and cannula into the hydated through the same channel. These methods are, however, dangerous and uncertain. A better method is to extract the cyst through a perforation in the cranial wall. If more than one hydated exists it is necessary to repeat the operation.

If the cranial bone shows a softened spot that is selected as the point to perforate. The skin covering it is scrubbed with soap and water, shaved, and rinsed with an antiseptic solution

(Mercuric chloride 1:1000). Then a boiled trochar and cannula of ⅛ inch bore, is pushed in ⅓ inch and the trochar withdrawn. The sheep may be turned on its back to favor the discharge, but it must be firmly held to prevent struggling with its legs or swaying or knocking its head. As the sac is emptied it will protrude through the tube and may be slowly pulled out with a pair of fine forceps. The cannula is now withdrawn and the wound covered with collodion or a pitch plaster. After the operation the patient may be kept in a dark box, secluded and quiet, and upon a laxative diet for 10 to 14 days, until danger of shock and inflammation have passed.

If the bone has not softened the point for perforation must be deduced from the symptoms. If the sheep turns in a circle the hydatid will usually be found in the centre of the hemisphere, toward which the turn is made, and the perforation should be in front of the ear and half an inch from the median line of the skull. If the head is elevated and a straightforward advance is made by the patient the perforation must be close to the median line. If the frontal crest is present (in a horned sheep) the perforation must be behind this, thereby avoiding the frontal sinus. If the lack of coördination of muscular movement and the excessive timidity suggest a hydatid in the cerebellum, the opening must be made ⅓ inch in front of the occipital crest and the point of the instrument must be directed through the membranous tentorium but sufficiently low to avoid the transverse sinus. The trephine usually employed has a solid pointed end like a triangular pyramid with sharp cutting margins, and with a screw on the shaft, on which works a disc-shaped shield to prevent the instrument from plunging into the brain when the bone has been perforated. The skin must be rendered aseptic, as nearly as possible, and then with a boiled or flamed knife an incision is made, the scalp and periosteum are dissected back, and the trephine applied. Then the hydatid is perforated and withdrawn with the aid of cannula, trochar, and forceps as in the other case.

Tænia Echinococcus (Sieb). A tapeworm of barely more than ¼ inch in length, and consisting of 4 segments only, including that of the head. As the fourth segment ripens it is promptly detached, leaving for the time but three segments, all immature. The globular head has four suckers and a pointed pro-

boscis bearing a double row of 28 to 50 hooks, remarkable for the great size of the guard or median process. The ripe caudal segment is about ½ of the entire length of the worm. The eggs are ovoid, 32μ by 25μ or slightly over. There may be 5,000 in a ripe segment.

The worm is easily overlooked in the colored contents of the bowel, but close observation will detect the minute yellow filaments, which become more visible when the liquid is cleared up by addition of water.

The habitat is in the small intestine of dog and wolf.

In some districts (Iceland, Abyssinia) they are often present in large numbers (1000 to 2000, Röll, Gervais) in a single dog, and cause digestive disorder with convulsions or delirium. The condition is distinguished from rabies by the absence of any mischievous propensity and of paralysis, and by the presence in the fæces of the ripe segments or of mature tæniæ. In Iceland 28 per cent. of the dogs had this tapeworm and 10,000 of the people suffered from the echinococcus, which the quacks treated with dog's excrement and urine.

Treatment. As for other tape-worms.

Echinococcus. (E. Hominis, Veterinorum, Polymorphus). The cystic or larval form of the echinococcus lives in a greater number of hosts of different genera, and finds its home in so many different organs of the infested body, that it is especially injurious and often fatal to the animals infested.

Habitat and Host. Entering as it does by the alimentary canal it most commonly makes its way to the liver to make its home there, but it is found not infrequently in the spleen, abdominal walls, kidneys, brain, lungs, pleura, connective tissue, bones and other structures, of man, ape, ox, sheep, goat, argali, elan, antelope, deer, camel, giraffe, horse, pig, elephant, tapir, kangaroo, rabbit, turkey and many other animals. Most herbivora and omnivora appear to be open to its attacks, but among domestic animals cattle and swine are the chief victims, and almost any organ of the body may be invaded.

Development. The ova laid by the ripe proglottis, and particularly the minute six-hooked embryo are introduced into the stomach and intestine, and the embryo at once begins to bore through the walls to reach a congenial larval home. They ap-

pear to travel first in the blood of the portal vein, and the majority are arrested in the liver, while others continue in the blood stream to reach distant parts and organs. Some doubtless reach the peritoneum direct, and develop in that membrane or on one of the abdominal organs. At first, growth is slow and in four weeks they may be represented by small globular cysts less than 1 mm. in diameter. These are usually directly under the serous membrane (in splanchnic cavities) but they may also be in the interior of a solid organ. In about eight weeks each has attained a diameter of $\frac{1}{15}$ inch and shows on its inner surface a layer of nucleated cells, the first trace of the inner or germinal membrane. At about the end of the fifth month it has reached the size of a walnut, showing a whitish, translucent, tremulous sac enclosed in a double membrane, the outer layer of which (hydatic membrane) is thick and dense (.2 mm.), and the inner (germinal membrane) thin and delicate (.12 mm. thick). The contents are saline, neutral, or slightly acid and among other things contain a poisonous alkaloid (leucomain) to which has been attributed the skin eruptions that appear when the cyst has burst into a large serous cavity. Exceptionally the echinococcus may be arrested at this point and remain a simple sac destitute of head or other definite organ (acephalocyst).

More commonly after some months interval the internal membrane (endocyst) develops papillary elevations on its inner surface, each of which becomes enlarged and hollowed out to form a cyst which remains attached to the parent cyst by a short pedicle. These are known as *secondary vesicles*, *proligerous cysts*, *daughter cysts*, *nurses*, or *brood capsules*, and they need not develop respectively their echinococcus heads or scolices. On the contrary the first group of broad capsules, may each develop within it a second group or generation (grand-daughter cysts) without heads, which in their turn may produce great-grand-daughter cysts still acephalous. At any time in the course of this development, these cysts or any one of them (primary, secondary, tertiary, etc.) may develop from its internal membrane the head of a tænia (scolex), the true larval echinococcus. Of these there are usually from 5 to 30 in the interior of each proligerous vesicle, varying in size so as to suggest a difference in age. When developed, the heads, or scolices are individually .19 mm. by .16

mm. in diameter, with a depression and orifice in the free end showing where the head has become invaginated within the sac. Thus it comes about that the hydatid, almost microscopic at its start and with no apparent organization except a simple chitinous membrane enclosing a clear or milky fluid, finally appears as a compound cyst, sometimes as large as an infant's head, containing numerous heads or scolices, some attached to the inner membrane of its parent sac, while others are detached, dead, and float free in the liquid.

Besides the *endogenous* formation of *proligerous cysts* and *scolices*, these sometimes develop outside the parent vesicle and hang from its outer instead of its inner surface. These *secondary external vesicles* are also formed from the internal parent membrane, but, bulging outward, they rupture the external membrane and remain pendant outside. They are more common in particular localities, and animals, and in such cases the tendency appears to be to the same form in a single animal, all being suggestive of a variety in the parasite. The *external vesicles* are most common in ruminants, pigs and men, and they rarely attain the same size as the other forms. The *internal vesicles* are most common in man, pig and horse, though also seen in oxen (Railliet).

Still another development of echinococcus is known as **E. Multilocularis** and characterized by the development of clusters of minute cysts in size from a millet seed to a pea and mostly sterile. Formerly called *alveolar, colloid cancer* these were identified by Virchow, who demonstrated their rather rare heads or scolices. They have been found mostly in man, but also very largely in cattle and pigs (Bollinger, Brinsteiner, Ostertag). They are also confined to particular countries, being unknown in Iceland and Australia, where the common echinococcus prevails, and frequent in Bavaria, Wurtenburg, Switzerland and Brandenburg. The specimens from cattle and pigs have been obtained mainly from the abattoirs of Munich and Berlin. All this seems to indicate a special variety of echinococcus.

Longevity of Cyst. With its power of indefinite encrease in numbers in the cystic form, echinococcus appears to have an extraordinary longevity without further development. In man a single case has persisted for thirty-five years (Courty), and an-

other for forty-three years (Raynal). In the horse one has been known to last for seven years (Raymond). When vital organs are attacked (heart, liver, kidney, brain) the case is usually cut short by interference with the normal functions.

Form. Size. Echinococcus cysts may thus be: (*a*) A simple *acephalocyst.* (*b*) A *simple fertile cyst* containing five or more heads or scolices. (*c*) A *complex cyst*, with *secondary vesicles, internal* or *external, some of the vesicles containing heads or scolices and some with none.*

In size the echinococcus cyst varies so largely that it is difficult to make a definite statement. The simple undivided cyst may be of any size up to about three (exceptionally five) inches in diameter. The compound cyst may reach to five, six or even more inches.

Lesions. These vary much with the stage of development and the organ in which the parasite is encysted. The enlargement of the invaded organ, the absorption of more or less of its substance, the presence of the cysts, simple or with daughter cysts, each with a double layer of investing membrane, the saline (NaCl.) nature of the contents, the floating of detached and devitalized scolices and free hooklets in the liquid, and the presence, in a given number of the cysts, of live heads or scolices attached to the inner membrane are characteristic. The enlargement of the affected organ will depend on the size and number of invading echinococci. There may be a single, simple cyst, or there may be numerous cysts, many of them with daughter cysts. With multiple invasion the ox's liver may come to weigh 100 pounds; extreme cases have shown 145 pounds (Roberts and Gregory), and 158 pounds (Ringk). In the pig an invaded liver of four pounds is not uncommon, while examples of 100 pounds (Cartwright), and even 110 pounds (Girard) have been recorded. The ox's lung has been found to weigh 100 pounds (Ringk, Friedberger and Fröhner) to 108 pounds (Morot).

In case of many echinococci the organ is usually irregularly bosselated on the surface and often seriously distorted. In old standing cases the walls are usually thickened, and there may be fibroid degeneration in the surrounding tissue. There may be an exudate inside the fibrous capsule, with blood or pus, and the contents may have degenerated into a granular, sebaceous debris.

The pressure from this product and the thickened fibroid walls may have led to collapse of the contained cyst, and to its contraction into a cicatricial or cretaceous mass. Even then the remnant of debris in the centre is liable to show some of the hooklets, the horny nature of which has enabled them to resist the process of disintegration. Another feature of these cysts is that the inner or hydatid wall contracts no adhesion to surrounding structures, from which it can be dissected leaving a smooth uniform surface.

Symptoms. Echinococcus is rarely diagnosed in the domestic animal during life. When invading the lungs the slow progress of the affection and comparative absence of fever serve to differentiate it from lung plague, as will also in many cases the multiple centres of consolidation, and the great prominence of the mucous râle. From pulmonary tubercle diagnosis is less easy, unless the tuberculin test is resorted to. If the liver is involved its bosselated surface can often be reached by the hand in the rectum. With serious disorder of both lungs and liver in a locality known to be free from lung plague and tubercle (but subject to echinococcus) and in an animal that does not respond to tuberculin, there may be a strong presumption in favor of echinococcus. If dogs are kept in company with the herd, and if one or more harbor Tænia Echinococcus the presumption is still stronger.

The loss of condition of the animal, the decline of appetite and rumination and the general unthriftiness and anæmia mark progress rather than specify the nature of the disease. In cases affecting the liver, jaundice is liable to appear, and in those affecting the kidney uræmia and various nervous disorders, and in both, dropsical effusion affecting the limbs, the lower aspect of the body; or the peritoneum or other serous cavity. Violent hepatic or renal colic will sometimes occur from the impaction of one of the detached scolices in the biliary duct or ureter. Such attacks are liable to be intermittent, temporary relief coming with the passage of the obstructing agent.

When an echinococcus aproaches the skin, fluctuation may sometimes be detected, and a tremor or thrill is described as characteristic. In such cases the fluid drawn off through a small cannula is found charged with sodium chloride, and if centrifuged the precipitate is likely to show the characteristic hooklets.

As symptoms vary with the organ affected, it may be well to say that the relative frequency of their invasion is about as follows: first, the liver (⅓ to ½ of all cases, (Davaine, Cobbold, etc.); second, the various other abdominal organs (spleen, kidneys, omentum, etc.), the abdominal walls and the lungs; third, the brain, heart, muscles, bones and other organs.

Geographical Distribution. Echinococcus is concentrated in given geographical areas, into which the parasite has been introduced, and where it has special opportunities for propagation by reason of the number of dogs and their intimate relation with man and domestic animals. In Iceland where dogs are nearly half as numerous as men sheep suffer to the extent of 20 to 100 per cent. (Hjaltelin), and 10,000 people at the same time (Krabbe). It is noteworthy that cows and ewes, kept around the dwellings, among infested men and dogs, are the principle victims: other stock on distant pastures in the main escape. In Mecklenburg 26 to 50 per cent. of oxen, 75 per cent. of sheep and 5 to 8 per cent. of pigs become victims (Madelung). In Prussia 200,000 francs are lost yearly by echinococcus (Schmidt). In India 70 per cent. of the cattle have liver echinococcus (Neumann.) Among the Buratis in Eastern Siberia, Kaschin found echinococcus in liver and heart of every one of the human population on whom he made a post-mortem examination. These people live in winter in the same tents with their cattle and dogs, washing neither their bodies nor dishes and wearing their clothes till they fall to pieces. Like the Icelanders they let the dogs clean their plates by licking them (Leuckart). Abyssinia closely follows Iceland and Siberia in the prevalence of echinococcus and Australia follows with a very large number of cases in both animals and men. (Thomas). The absence of any winter in Australia and Abyssinia, and the aggregations of ruminants and dogs, together with the simple nomadic life of the shepherds, strongly conduce to the preservation and spread of the parasite.

Treatment. No drug is known which given internally will certainly kill the echinococcus cyst. De Renzi, claims success, in cerebral and liver cysts in man, from prolonged use of etherial extract of male fern, 2 to 4 capsules per diem. Electricity though warmly advocated by some has proved unsatisfactory. Yet spontaneous recovery is not unknown, through the rup-

ture and evacuation of the cysts or through the death of the echinococcus and degeneration of its contents. When ruptured it may be recognized by the density of the liquid (1007 to 1009), by the excess of sodium chloride, the absence of albumen and above all by the presence of heads (scolices) or hooklets. An exudate of blood or lymph beneath the outer layer of the cyst may be the occasion of its death. The exudate degenerates into a sebaceous like debris, which compressing the inner membrane causes it to pucker up and expel its liquid contents. As the exudate increases the cavity grows gradually smaller and is finally obliterated or retains only the hooklets of the dead scolices. The debris may resemble putty or chalk, though in man it may suggest softened tubercle.

The evacuation of the cyst by trochar and cannula, followed by injection with tincture of iodine to be left in the cyst for five minutes and then drawn off has repeatedly succeeded. The contents of the cyst are first thoroughly drawn out by the aid of a syringe, then the iodine is injected, left for five minutes and again fully drawn off. If the trochar has to penetrate any serous cavity great care is taken to prevent any scolices from escaping into this. Also, whenever a hydatid is laid open by spontaneous rupture, by the knife, or by the trochar, the walls of the sac should be extracted if possible, as this will absolutely prevent its reappearance *in situ*.

Prevention. While the wolf is a possible source of the echinococcus ova, it is to the dog that we must look as the almost exclusive source of the parasite in well settled and cultivated districts. In the dog the disease can be recognized and the propagation of the parasite through the mature worms and their eggs can in him be arrested, so that by attention to the dog this deadly tape-worm can be exterminated. Effective measures should include the following: 1. The destruction of all superfluous dogs and especially of homeless and neglected ones. 2. The strict supervision of all dogs to prevent them from visiting abattoirs or other places where they may eat the raw offal of animals. 3. The medicinal treatment of all dogs passing segments of tapeworms, especially of shepherd dogs employed on the pastures, and the destruction of other dogs found on such pastures. 4. The

exclusion of dogs from the vicinity of wells or supplies of drinking water for man or beast. 5. The sterilization as far as possible, by burning or boiling, of the dung of all dogs that suffer from tape-worm and of all taken from kennels, and the destruction in the same way of all the contents of evacuated hydatids and of offal containing such cysts. To these may be added: 6. The filtration or boiling of all drinking water and especially of that drawn from shallow or imperfectly cemented wells in gravelly or otherwise porous ground.

Dipylidium Caninum. Tænia Canina. T. Cucumerina. Melon-seed Tape-worm. This is 3 to 12 or 14 inches long and 3 mm. broad in mature segments. The head is elongated and terminated by a very protractile club-shaped proboscis armed with four rows of small recurved hooklets like the thorns of a rose. When retracted the proboscis is sunken in a median pit and surrounded by the four sucking discs. The first segments are short and nearly round or disc-shaped, the last are ellipsoidal like melon-seeds (cucumis, hence the name). Genital organs double with two pores, one on the centre of each lateral border, right and left, and on a slight elevation. Ova globular, 37μ to 46μ in diameter.

Habitat. Abundant in the small intestine of the dog. Rarely in man.

Cryptocystis Trichodectis. Cr. Pullcides. The cystic form of the T. Canina is encysted in the dog louse (Trichodectes Latus) or in the dog flea (Pulex Serraticeps), according as one or other may be the most convenient. The cyst was found in the enlarged abdomen of the louse in 1869 by Melnikow, and more recently in the body of the flea by Grassi. If a paste made by crushing the ripe segment of the canina is placed on the skin of the dog at a point infested by one of these skin parasites, a number of the latter soon show enormously distended abdomens, and examination reveals the scolex in the centre of the swelling. In seeking to rid himself of the vermin the dog swallows the infested louse or flea, and the scolex develops in his intestine into the Tænia Canina.

There is therefore abundant reason for the great prevalence of the tape-worm before us, and especially in poor, neglected, dirty, vermin-infested dogs. There is also the obvious resort in treat-

ment and prevention in the use not only of tæniacides for the destruction of the mature worm, but also of parasiticides for the destruction of the vermin on the skin.

Tænia Litterata. T. Pseudo-Cucumerina. T. Lineata. T. Canis Lagopodis. T. Margaritifera. Mesocestoides Litteratus. Lettered T. These have been held to be one species and again divided into three separate ones. It has also been questioned whether they do not belong rather to the bothriocephali to which the absence of proboscis and hooklets, and the very restricted development of generative organs with pores near the center of the ventral surface, seem to ally them.

The **Tænia Litterata** has a globular head, slightly flattened or bilobed, .9 mm. broad, without proboscis or hooks but with four suckers each having a wide longitudinal slit. The neck is long, at first narrowing insensibly and then slowly widening and the first segments appear about an inch behind the head. The anterior segments are distinctly narrowed in front and behind, while the riper segments are in the main wider behind. The genital pores are not lateral but are double, the vulva in front of the male orifice, near the middle of the ventral surface. The pyriform uterus, near the posterior border shines through the transparent envelope giving the peculiar lettered appearance to the segment. The mature worm is one to two or even five feet. Eggs, very numerous, with thin transparent walls showing the living embryo within, which retains its vitality in spite of freezing or drying (Baillet). Ova 40 to 60μ by 35 to 43μ.

Habitat. Small intestine of the dog in Iceland and Europe. The head is usually so firmly attached to the mucosa that it may remain when the worm is pulled off.

Larval form unknown.

Bothriocephalus Latus. Broad B. Length 25 feet or more, breadth about 1 inch at its greatest. Head $\frac{1}{25}$ inch, oblong, club-shaped or lanceolate, flattened with two lateral pits (bothridia) used as suckers, and devoid of hooklets. First segments very short and narrow, enlarging very gradually; in the middle of the worm they are three times as broad as long, and from this backward they slowly decrease in breadth, becoming quadrate and finally square, through the ovulation and subsequent atrophy of the generative organs. The segmen-

detached, full of ova as in tæniæ, but as the eggs are laid in the bowels of the host the oviducts and segments both shrink, so that when the segment finally drops off it is a mere little cube. The total segments are about 4000, and the sexually mature ones are behind the 600th. The sexual pores are not marginal but near the centre of the ventral surface on a small tubercle, the male pore in front and the female behind it. The oviduct is a tube folded on itself to form a rosette toward the centre of the segment. Eggs ovoid, with operculum at one end, 68 to 71μ long by 44 to 45μ broad. The eggs usually lie for months in water before hatching out the globular ciliated embryo, which later sheds its covering and appears as a six-hooked embryo, like that of the tænia. The sexual organs are sometimes double.

Habitat. Intestine of man, dog and cat.

Distribution. The parasite is in the main confined to certain localities, out of which it is only met with in individuals that have visited the infested districts. These include the Western Cantons of Switzerland and adjacent parts of France; the north of Italy; the North Western and Northern provinces of European Russia and Poland; the Baltic shores of Finland, Sweden, and Denmark; Greenland; Southern Russia; Holland and Belgium; some points in Eastern Prussia, Pomerania, Rhenish Hesse, and the cities of Berlin, London, Hamburg, San Malo, Zurich, Rome and Montpelier.

These are in the main seacoast or lacustrine regions, or those in which fresh fish from infested waters form a staple article of diet. Yet from unknown causes it may disappear from formerly infected districts. Odier claimed that one-fourth of the inhabitants of Geneva suffered comparatively recently, yet to-day it has virtually disappeared from the city.

Larva. Plerocercoides. Braun found these larval forms in the intestinal walls, muscles and other tissues of pike and turbot. They show no generative organs and have the head invaginated. Feeding them to dogs and cats which he carefully secluded from other sources of infestment, he constantly developed the mature worm in their intestines. Parona, Ferrara, Grassi and Rovalli similarly matured the larvæ by feeding them to dog and man. It can therefore be taken for granted that the normal source of bothriocephalus for man and dog is through devouring the larvæ

in fresh fish. In addition to the pike and turbot, the tench, grayling, perch and other fishes harbor the larvæ. Other experiments, however, seem to show that the larval stage in the fish is not essential, but that B. Latus may be developed from the ovum to maturity in the intestine of the dog.

Bothriocephalus Cordatus. Heart-shaped B. This form is smaller than B. Latus, being when mature 2½ to 4 feet long, and having 400 to 600 segments. Its striking features are that the head is heart-shaped (obcordate), compressed from side to side and broadest from above downward, and with two bothridia, one on the upper and the other on the lower margin. It has no neck, but broadens rapidly, shows segmentation from the head backward, and reaches its greatest breadth at 6 cm. behind the head. The uterine rosette is longer and more branching, but of smaller calibre than in B. Latus, and the body contains more calcareous particles.

Orlik found B. Cordatus very prevalent in the dogs of Godhaven, N. Greenland, six dogs furnishing as many as 20 specimens. Plaff found 23 in three dogs, and one in a seal. Zimmer found the worm in a walrus. It was much less frequent in man, and has not been found out of Greenland. This speaks for its transmission in larval form through the fish of the Greenland Seas to the marine and terrestrial mammalia of the locality.

Bothriocephalus Fuscus. Dark B. This worm is 3 to 27 inches long, with flat, lanceolate head, and segments beginning near the head and encreasing until longer than broad. The oviducts show as a dark-blue spot in the centre of the segment and suggest the name. Calcareous particles are absent. Krabbe found this in two dogs in Iceland, one having 22 specimens of different sizes.

B. Reticulatus and **B. Dubius** are two closely allied specimens found in dogs in Iceland.

The *treatment* of bothriocephalus is essentially the same as for tænia. *Prevention* is to be sought in the thorough cooking of all fish fed to dogs or men, and the exclusion of dogs from all curing establishments or other places where they might get the uncooked products.

INTESTINAL TREMATODES AND NEMATODES IN DOGS.

Hemistoma Alatum: 3 to 6 mm. long, heart-shaped, lateral wings to mouth; in fox and dog. *Distoma Echinatum:* 4 to 15 mm., red, lanceolate, spiny; in ducks, geese, etc., and in dog's duodenum; experimentally in small rodents, sparrows. Pathogenesis: Duodenal catarrh; vermifuge treatment. *Echinorhynchus Canis. Ascaris Marginata:* Tapering at ends, head alated, mouth triangular, three tuberculated lips, ova globular, reticulated; in duodenum and stomach of dog, wolf, fox (and cat). *Symptoms:* Vomiting the worms, catarrhal diarrhœa, unthrift, emaciation, dry, scurfy coat, pot-belly, variable appetite, colic, epilepsy, disordered intellection, taciturnity, duodenal catarrh, hæmorrhagic enteritis. *Treatment:* Areca nut powder, santonin, etc *Prevention:* Vermicides, pure water, burn dog manure, scald feeding and drinking dishes. *Oxyuris Vermicularis: Uncinaria Trigonocephala:* Bent upward near head, so that mouth deviates: 9 to 21 mm. long, lateral jaws each with three teeth; eggs ovoid; in small intestine of dog and fox. *U. Stenocephala:* Smaller than last, 6 to 10 mm. long; mouth small with one sharp ventral tooth: both *uncinaria* found in same dog. *Uncinariosis:* Shown in packs, in damp kennels, near water. *Symptoms:* In ratio with young worms taken; debility, emaciation, spiritlessness, early fatigue, languid, sunken, pale eye, white mouth, unthrift, dandruff, red patches on stifles, inside thighs, or elbows, dry nose with purulent or bloody discharge, dropsies, bleedings at intervals, diarrhœa, sloughing; death in a few months or a year. *Diagnosis:* Enzootic prevalence, with above symptoms, and worms or ova in mucus or surface layer of fæces. *Necropsy:* Bloodless, hydroæmia, duodenal congestion with adherent worms, softened lymph glands. Treatment: Vermifuges, tonics, generous feeding, thymol, areca nut, male fern, kamala, Fowler's solution, iron, pepsin. *Prevention:* Quarantine strange dogs, give vermifuges, give water from deep cemented wells only, scald and whitewash kennels, manure burned. *Whip worm of dog:* In cæcum; direct from egg in 8 months. Cause congestion, thickening, catarrh, diarrhœa, licking anus or drawing it along ground, etc. *Treatment:* Vermifuges. *Prevention: Trichina Spiralis: Filaria Hepatica:* In intestinal and biliary walls; possibly larvæ.

Hemistoma Alatum. The Winged Hemistome. This trematode, 3 to 6 mm. long by 1.5 mm. wide, has an elongated heart-shape, and a pointed wing-like projection at each side of the mouth which is terminal. It is common in the fox and was found by Schöne in 5 per cent. of draught dogs examined.

Distoma Echinatum. Spinate D. Body 4 to 15 mm. long and .5 to 2 mm. thick, rosy red, lanceolate, and skin covered

with fine spines anteriorly and obtuse plates behind. Head separated from the body by a narrow constriction, and throughout covered by sharp spines except below where there is a deep pit. Ventral disc 3 or 4 times as large as the oral one. Ova brownish yellow, 94 to 110μ long, by 75μ broad.

Habitat. This is common in ducks, geese and aquatic birds, has been found in the duodenum of the dog (Generali), and was produced experimentally in rats, mice, moles and sparrows.

It has been very largely availed of in tracing the pathogenesis of the trematode, and hence its successive stages of growth, and homes, as: 1. The ovum. 2. The ciliated embryo. 3. The brood capsule (redia) encysted in the lungs, etc. of a mollusc. 4. The daughter sporocyst in the liver. 5. The free swimming young trematode moving in the water or attached to an aquatic plant, ready to be taken in by its mammalian host (see Distoma Hepaticum); are well known.

Pathogenesis. From the mature of the armed head this trematode can hardly fail to prove very hurtful to its host, and Generali noted in his infested dog, severe duodenitis and many yellowish gray spots indicating previous points of attack and phlegmasia.

Treatment would be by any one of the active vermifuges.

Echinorhynchus Canis. Kaupp records a mature echinorhynchus, found by J. W. Parker at San Antonio, Texas, in the intestines of a dog. The specimen was an ovigerous female, of half an inch in length, while the mature echynorhynchus gigas measures from 7 to 11 inches. Its protractile proboscis bore but six rows of retractile hooklets, in this approximating rather to the *E. Sphærocephalus* than to the E. polymorphus or E. fillicollis of the duck. The elliptical ova agree with the form of those of the other known echinorhynchi. A special bulging of the rostrum and anterior part of the neck again suggests the sphærocephalus.

As the parasite has been hitherto unknown in the dog, and is now represented by a single specimen only, the question naturally arises whether the dog had recently eaten a duck and acquired the parasite fully developed, or if it had taken in the larva with its invertebrate host long before, and had developed it to maturity in its own intestine? To fulfill the latter condition, a male echinorhynchus must also have been taken in but that may have

escaped in the interval, or have been overlooked in examining the intestine of the dog. The fact of the discovery must be recorded and further observation in the same line must be invited to throw clearer light on the question.

Ascaris Marginata. Bordered A. Maw Worm. A. Mystax. Body white or pale pinkish brown, narrowed at both ends, tail pointed. *Male*, 5 to 10 cm. long, tail curved and furnished with two lateral membranous wings and twenty-six papillæ on each side—two post-anal. Two spicula. *Female*, 9 to 12 cm. long; blunt tail; vulva in anterior quarter of the body. *Head* usually slightly curved and furnished with two broad lateral alæ giving the appearance of an arrowhead. Mouth triangular, closed by three lips, each bearing a tubercle in the middle of its outer surface. Œsophagus club-shaped, ending behind in a nearly globular ventricular enlargement. Ova almost globular, 75μ to 80μ in diameter, with reticulated surface.

Habitat. Small intestine and stomach of dog, often brought up in vomiting, hence the name of *maw-worm*. It is common also to other species of the canine family like the fox and wolf. The identity of this parasite with the Ascaris Mystax of the cat is at present claimed by the majority of helminthologists in spite of the marked difference in the size, and, this accepted, man must be added as a possible host.

The worms are most frequent and abundant in young dogs, from three or four weeks old to two or three months. Any age, however, may suffer. Being so common they are liable to be very numerous.

Pathogenesis. Symptoms. When present only in small numbers in a mature, well-conditioned dog they are often of very little account. When numerous or in the young or weak they may produce the most varied symptoms, local and general. The vomiting of glairy matter containing the worms is a common and conclusive symptom. As in all irritations of the small intestine there is likely to be irregularity of the bowels, with at times a transient or catarrhal diarrhœa. Among general symptoms are to be noted itchy anus, unthrift, emaciation, dry scurfy coat, pot-belly, variable appetite, colic, constipation, epilepsy and disordered intellection which has been confounded with rabies. There is, however, rather taciturnity and snappishness than a disposition

to commit malicious mischief. When present in large numbers they may cause severe indigestion, or they may even completely obstruct the intestine.

Lesions. From the fact that ascarides live free in the contents of the bowels and do not bite nor suck blood, extensive lesions are not to be looked for. Yet catarrhal swelling of the mucosa of the small intestine is not uncommon, and intense hæmorrhagic enteritis may be met with, in which the mucosa is congested, thickened by exudate and marked by small black spots, or sloughing fissures on the folds and ulcers.

Treatment. For young puppies and weak or emaciated dogs, areca nut is one of the best agents in the dose of ½ dr. to a two-month's shepherd puppy. Benzine in doses of 1½ dr. is recommended by Zurn. Santonin, 5 grs. in ½ oz. castor oil is effective. Male fern extract, 10 to 20 grs. alone or in combination with santonin or areca nut may be used. For Ascaris Marginata, which is always free in the contents, mostly of the duodenum, the vermifuges generally are effective, as they can be promptly brought into intimate contact with the parasite, and as the latter subsists on the chyme, it cannot choose but take in the deadly drug. A main danger is that of the rejection of irritant or nauseating agents by the stomach, and hence the great value of areca nut and other nonirritating agents.

Prevention. As the ascaris develops in the bowel directly from the ovum or embryo taken in with food or water, every effort must be made to prevent its admission by these channels. Ponds and streams that receive drainage from the droppings of affected dogs (kennels), and wells in porous soils which receive surface seepage should be avoided as far as possible, and the water from such given only after it has been boiled. Even the vomited matter, charged as it may be with the ascarides and their eggs may be discharged into drinking water or feeding vessels, and infest other animals as well as the one that furnished it. The frequent washing and scalding of feeding dishes is therefore no less important than the expulsion of the worms from dogs that live in the same place.

Oxyuris Vermicularis. Zurn claims to have found this parasite of man in a dog but as no one else has, there is a strong probability of error. In any case it must be extremely rare.

Uncinaria Trigonocephala. U. Canina. Anchylostoma T. Dochmius T. White body abruptly narrowed near the head and bent (hooked) upward. *Male* 9 mm. to 12 mm. long, with trilobate caudal membrane, the middle lobe, the smallest. *Female* 9 mm. to 21 mm. long, tail obtuse with a mucron or sharp process, vulva toward the posterior third of the body. Mouth round with buccal capsule furnished ventro-laterally on each side with a hard chitinous curved jaw, terminating in three strong sharp teeth turned inward and backward; two smaller teeth project downward from the dorsal border. *Eggs* ovoid 74μ to 84μ long, by 48μ to 54μ broad.

Habitat. Small intestine of dog and fox, in company with the U. Stenocephala.

Uncinaria Stenocephala. Anchylostoma S. Dochmius S. This worm is smaller than the above species. *Male* 6 mm. to 8 mm. long, with same form of caudal membrane. *Female* 8 mm. to 10 mm. long, with the same acute prolongation on the tail, and the vulva in its posterior third. The mouth differs strikingly; the head is small and the buccal capsule constricted, with a ventral chitinous fold and sharp border covering one sharp tooth. The dorsal border has a median depression but no distinct tooth. Eggs ovoid, 63μ to 67μ long, by 32μ to 38μ broad.

Pathogenesis. Habitat. This occupies the small intestine in the dog, in company with U. Trigonocephala, producing a pernicious and fatal anæmia with other acute symptoms. It attains its most destructive prevalence in dogs kept in *packs*, and this is known as *Pernicious Anæmia*, *Uncinariosis*, or *Bleeding from the Nose* of packs of hounds.

UNCINARIOSIS OF PACKS OF DOGS. BLEEDING AT THE NOSE.

Causes. The essential cause of this disease is the presence in the small intestine of the uncinaria in large numbers. Accessory conditions, however, contribute much to its prevalence. Its notorious extension in *packs* or large kennels is, the same as in all verminous epizoötics, the result of the bringing together of the parasite and large numbers of the hosts on which it preys. Every host can harbor an indefinite number of worms, and every female worm can produce, in short order, thousands more. But the collection in private packs is not an essential condition, all

that is required is the accumulation in a given locality of great numbers even of private dogs. Stiles assures us that uncinaria are exceedingly common in the numerous dogs of Washington, D. C., and that in some districts 25 to 40 per cent. of the pups die from their invasion.

An important factor is the presence of water. The young embryos and immature worms live in water and moist earth (see under U. Cernua) and enter the host by the mouth or through the skin. A wet kennel or run, damp locality, the presence of pools into which the drainage from kennels or defecations runs, or of sluggish streams is, therefore, strongly conducive to the propagation and encrease of the worm. In kennels, the contamination of the drinking troughs or dishes, by infested members of the *pack*, ensures a speedy and general diffusion of the helminth and the consequent epizoötic.

Symptoms. These vary with the number of young worms introduced from without as they cannot develop from the egg to maturity in the intestine of the dog. When badly infested there is rapidly advancing debility and emaciation, a loss of spirit and energy, an inability to endure fatigue, an indifference to hunting, a languid sunken eye, some pallor of eyes and mouth, a dry unthrifty coat, dry skin with shedding of scurf or dandruff, the appearance of red erythematous patches about the stifles or inside the thighs or elbows, a dry, chapped nose, a muco-purulent nasal discharge and in time dropsical effusions in the limbs and it may be into serous cavities. Sooner or later there is epistaxis, at first merely staining the purulent nasal discharge, but later more abundant, bright red and profuse. The hæmorrhages recur at intervals of days or weeks, the muco-purulent discharge continuing in the intervals, and as much as two ounces of blood may be lost at one time. In the end diarrhœa sets in, becoming more and more profuse and fœtid, dark by reason of the effused blood and charged with mucus, epithelium and even sloughs. The weakness becomes extreme and conduces with the constant recumbency to sloughing of the skin from prominent points, and indirectly to local infections and poisoning. The patient may survive a few months or it may be a year according to the degree of infestment, and death takes place in coma or convulsions.

Diagnosis is based on the enzoötic prevalence of the disease, especially in packs or kennels, on its progressive extension and

encrease, its chronic tendency, on the itching anus, rhinitis, epistaxis and diarrhœa, and on the growing evidences of anæmia, emaciation and weakness. But the conclusive evidence is secured in the discovery in the fæces of the uncinaria or their ova. The microscopic examination of the mucus from the defecation, or of the surface layer will be likely to reveal the presence of the eggs, and should this fail, the process of sedimentation (see under U. Cernua) should be tried. Should even this fail a course of anthelmintics should be administered and careful search made in the fæces, (including sedimentation) for the presence of the worms.

Lesions. On *post-mortem* examination the pallor and bloodlessness of the various mucosæ and other white tissues, stands out in a marked way and the muscular system is pale, soft and flabby. The blood lacks its rich, healthy, deep red color, and is watery with a notable lack of red globules, and stains white paper less deeply than in health. The duodenal mucosa, and to a less extent that of the jejunum and ileum, shows patches of congestion and marked infiltration and thickening, the villi being enlarged to five times their normal size and closely packed together, and on these as well as on the other parts of the mucosa are deep red hæmorrhagic spots indicating the points attacked by the parasite. The washed mucosa shows the worms in greater or lesser numbers attached by their mouths to the mucosa. The numbers are greater in recent, severe cases, in a locality where the parasite has been long prevalent, and with ample means of distribution. There may, however, be a few only, found in certain old and chronic cases, in which the destructive early crop of worms have died and been discharged, leaving the irreparable local lesions, anæmia and marasmus. Swelling and softening of the lymph glands of the mesentery is a marked feature of these advanced cases.

Treatment. Beside the measures adopted to prevent the introduction of more embryos, this consists in vermifuges, tonics and rich feeding. Choice may be made from the different anthelmintics but the following are especially to be recommended : Thymol 5-10 grs. according to the size of the puppy ; or male fern extract. In weak subjects areca nut, 20 to 30 grains daily, is a safe and available drug. As in other forms of intestinal parasitism the

patient must be prepared by a fast for a day, and better still by a laxative. Megnin gives kamala in doses of 40 to 60 grains, with or without ½ a grain of calomel. Combinations of different agents can be advantageously resorted to.

The strength of the patients must be maintained by the most generous diet (milk ; raw meat scraped or pulped for weak subjects), and by tonics, nux, gentian, echinacea, Fowler's solution, iron, pepsin, etc.

More than all, the preventive measures must be sedulously carried out.

Prevention. Avoid the aggregation of dogs on small areas. In *packs*, every effort must be made to exclude the parasite, and new dogs, especially such as come from suspected districts, must be placed in quarantine and treated with vermifuges before joining the rest. In cities a strict enforcement of license fees, and the destruction of ownerless and neglected dogs are all important. In infested localities valuable dogs should not be allowed to quench their thirst at any exposed pool or stream. At home the water should be drawn from deep wells, in impermeable soils and with the mouth and upper strata carefully cemented against seepage or drainage. The watering and feeding troughs and dishes must be washed daily and thoroughly scalded with boiling water. The kennels must be frequently scrubbed with soap and water and scalded, and may then be whitewashed with recently burned quicklime, or with chloride of lime ¼ lb. to the gallon. The floors and yards should be washed daily and kept scrupulously clean, so that the dog will not carry the embryos on his feet to the bone or food that he devours. They may even enter through the skin. Extreme cleanliness is needful in the feeding place and it is better not to give food nor bones to be eaten from the ground outside. Every affected animal must be instantly removed and placed by himself for treatment and the kennel and yard must be thoroughly disinfected. The manure from the [illegible] should be burned, or mixed with quicklime or freely [illegible] water and used on land that is not frequented by dogs.

Trichocephalus Depressiusculus. *Whip worm of the Dog.* This has the same length [illegible] 75 mm., and the cephalic filiform [illegible] of the entire length. The skin is marked [illegible]

verse striæ. The mouth is very small and terminal, the anus is also terminal in the female, while in the male it opens in front of the end by an orifice common also to the genital organs with which the intestine has united to form a cloaca. In the *male* the spiculum is excessive in length, and its sheath is covered with blunt scales in the proximate half. The *female* has a single ovary which, as a dilated tube, extends from near the anus to the anterior portion of the thick division of the body, curves back as a smaller tube, and ends in a dilated sac (uterus), the efferent duct of which opens on an elevation near the line of union of the thick and filiform parts of the body. Eggs oval, 70μ to 80μ long, by 32μ to 35μ broad.

Habitat. This worm is found, not unfrequently, in the cæcum of puppies and older dogs, with head and neck deeply buried in the mucosa sucking the blood. Railliet found what he believed to be the same species in the jejunum of a ferret. The whip-worm of the fox, as described by Dujardin, presented minor differences, yet it is probably the same with the Depressiusculus.

Development. Railliet found that the ova placed in water in February took five months to form complete embryos, and that such eggs fed to dogs without breaking the shells, developed into the mature worm in three months more. This allowed eight months for development into the mature parasite, and showed the complete evolution without the intervention of a secondary host. This agrees with what is known of the other trichocephali.

Pathogenesis. The whip-worm is reputed to be comparatively harmless to the dog, but this is based on the fact of their usual paucity in numbers. When present in force they, as blood suckers, cannot fail to be equally injurious with the whip-worm of man or pig. Megnin found under these conditions a congestion and inflammatory thickening of the cæcum, with irritation which sometimes resulted in invagination. Where conditions are favorable to the preservation of the ova in water and the introduction in numbers into the puppy, of the still encapsulated embryo, one must expect to find catarrh of the bowels, irregular appetite, occasional diarrhœa, drawing the anus along the ground, or licking of the anus, dry unthrifty coat, scurfy skin, pot-belly and emaciation.

Treatment will not differ materially from that of the ascarides

or uncinaria, and *prevention* must follow the same lines. The fact that the eggs require so long for hatching and that they may be dried up and arrested in their development for an indefinite length of time renders them at once less likely to encrease rapidly to a dangerous degree, and less easily eradicated from an infested area.

Trichinella Spiralis. This invades both the bowels (mature) and muscular system (larva) of the dog, but it is fully considered in connection with the muscles.

Filaria Hepatica. Mather found round worms encysted in the intestinal mucosa and gall ducts of the dog, and Cobbold named them as above. Railliet thinks they were the larvæ of other forms.

Strongyloides Canis. S. Longus. The dog is not immune from attacks of strongyloides though Gonder claims that the larvæ of the S. longus, entering the cutaneous glands, do not make their way beyond the skin, into the circulatory channels and intestines. With the delicate integument of the dog, however, and its liability to disease, the presence of the worms even in the skin cannot be looked upon as an unimportant occurrence. *Preventive* measures are as essential as for other animals, and the treatment of such a verminous skin affection, as of the deeper intestinal disorder must be met by distinctly anthelmintic treatment.

INTESTINAL PARASITES OF THE CAT.

Sporozoa, Coccidium Rivolti. Lamblia Intestinalis. Tænia Crassicollis: 5 to 20 inches long; proboscis with 26 to 42 hooks, handle longer than blade, neck very thick, ripe segments longer than broad; in small intestine fixed to mucosa by hooked proboscis. *Pipe-like Cysticercus*; The larva, in liver of small rodents, tubular with pea-like anterior dilation and opening for invagination of head. Cause gastric disorder and general debility; perhaps epizootic; anorexia, vomiting, diarrhœa and constipation, salivation, emaciation, colics, deafness, epilepsy, proglottides in fæces. Lesions. Treatment, tæniafuge. *T. Elliptica:* Like canina but not interchangeable; 3 to 10 inches long; larva unknown. *T. Litterata*, as in dog. *Bothriocephalus Felis:* Species uncertain. *Ascaris Mystax* (Marginata): Smaller than in dog. *Oxyuris Compar:* In small intestine. *Uncinaria Trigonocephala*, as in dog. *Uncinariosis.* Progressive debility, emaciation, softness, spiritlessness, variable appetite, vomiting, diarrhœa, soiling tail, anæmia, pale, sunken eyes; death in a month or later, or recovery. Diagnosis: number

of victims ; black, offensive diarrhœa, passage of worms or ova, catarrhal enteritis, hydræmia. *Treatment* and *prevention*, as in dog. *Trichosoma Lineare :* Tapers to ends in male, caudal end hair-like and coiled in female. *Spiroptera Sanguinolenta Ollulanus Tricuspis.*

Sporozoa. Coccidium Rivolta, a close ally of the C. PERFORANS of the dog is found in the intestinal epithelium of the cat, enclosed in a membrane with double contour. Free in the intestine it has an oval outline and in water it passes through the same successive developmental stages as the C. Perforans. Fick describes a larger Coccidium (80 to 100μ long by 70 to 90μ wide) as abundant in the intestinal villi of the cat and assisting in the absorption of fatty substances.

Infusoria. Lamblia Intestinalis which is common in sheep and dog is also found in the cat.

Cestodes. Tænia Crassicollis. Thick-necked T. This is an armed tænia with large head and usually thicker neck, and from 5 to 20 inches long. Its rounded probosis is furnished with a double row of 26 to 52 hooklets, the handle being longer than the blade. Segmentation begins at once in the thick neck, and they become square 15 or 20 centimetres behind the head :—4 to 5 mm. across. The ripe segments measure about 8 to 10 mm. long, by 5 to 6 mm. wide. Ova circular 31 to 37μ in diameter.

Habitat. The small intestine of the cat where the head is usually fixed by its hooklets to the mucosa.

Cysticercus Fasciolaris. The Band or Pipe like C. The cystic or larval stage of the *T. Crassicollis* is found in the liver of rats, mice and other small rodents (Norway rat, water rat, vole). It is remarkable for its long narrow pipe-like form, coiled up in a cyst the formation of which has been caused by its presence. It ends in front in a small pea-shaped vesicle having an opening showing invagination of the head and is prolonged behind by a distinct chain of segments, devoid of sexual organs. The cyst may be from one to six inches in length. The cyst has been experimentally developed in the intestine of the cat (Von Siebold) and the ripe segments of the Crassicollis have developed the pipe-like cyst in the liver of the rat (Baillet). It appears to have been the suggestive resemblance of the pipe cysticercus of the rat to the T. Crassicollis of the cat that induced Von Siebold to experiment with the cyst on the cat, and thus to ellucidate the method of evolution of the tape worms.

Pathogenesis. T. Crassicollis is common in the small intestine of the cat and if solitary does not seem to seriously impair the health, yet when very numerous they may be the cause of serious ill health which may even assume the form of an epizootic. Such out-breaks have been noticed in Italy (Romano), in the Black Forest (Lydtin), and in Austria (Zschokke).

Symptoms were gradual loss of appetite, vomiting, retracted abdomen, alternation of diarrhœa and constipation, salivation, emaciation, loss of weight, colics, deafness, epilepsy, and the passage of proglottides with the fæces.

Lesions consisted in the presence of the tape-worm, intestinal catarrh, enteritis, gastric catarrh, and in certain cases rupture of the intestine (Perroncito, Grassi and Parona).

Treatment is the usual tæniafuge course.

Tænia Elliptica. This bears a great likeness to *T. Canina* (Dipylidium Caninum) but is at least a variety as the segments develop much more rapidly and it appears to be absent from Iceland where T. Canina abounds. Krabbe who made this observation found *T. Elliptica* in half the cats examined in Copenhagen, one containing as many as 600. Its length is 10 to 30 centimetres, greatest breadth 3 mm. Eggs globular .49 to .54μ in diameter. Has been found in man.

The *larval form* of this tænia is unknown.

Tænia Litterata. This is supposed to be identical with the T. Litterata of the dog, though Baillet claims a distinction in the smaller size of the ova, 31 to 36μ.

Bothriocephalus Felis. B. Decipiens. Dibothrium D.. B. Latus. A number of observers have found Bothriocephalus in the domestic cat, but the exact species in the different cases has not been rendered quite certain. The characters as given by Davaine were : " Head oblongate oval ; lateral bothrida opening backward and mostly closed by approximation of their lips; neck long, thin; anterior segments parallelopipeds, the median very long, the posterior almost square, the terminal rounded; length of head, 3 mm.; breadth, 1 mm.; length of the median rings, 9 mm.; of the posterior, 4 mm.; total length, 1 metre 60 centimetres" (3 feet 23 inches). As no one has noticed that the worm was specially injurious it need not be further noticed.

Ascaris Mystax. Ascaris Marginata. This presents all the characters of the ascaris of the dog, of which it is considered to be a smaller variety. The *Male* is 4 to 6 cm. and the *female* 4 to 10 cm. It is found especially in the stomach and intestine of young cats, but may be in those of any age. Krabbe found it in 50 per cent. of all cats examined and in numbers varying from 1 to 80. Unless numerous it does not seriously affect the health, but if abundant they cause nausea, vomiting, capricious appetite, indigestion, diarrhœa, emaciation and loss of weight.

The best treatment is usually by areca nut, 5 to 10 grains daily.

Oxyuris Compar. Female worms 8 to 15 mm. long were found by Leidy in the small intestine of a cat at Philadelphia.

Uncinaria Trigonocephala. Dochmius Balsami. Railliet has demonstrated the identity of this worm with that causing pernicious anæmia in the dog.

Habitat. The duodenum of the cat, the worms being firmly attached by their hooks to the mucous membrane.

UNCINARIOSIS IN CATS PERNICIOUS ANÆMIA.

Symptoms. These vary with the number of worms. One or two may do no appreciable harm, while if the embryos are constantly taken in in the water a progressive weakness and debility are rapidly developed. About the first symptom is loss of weight and encreasing emaciation. The plump roundness, and lithe activity give place to a soft flaccid condition, dulness and indisposition to exertion. Then there are irregular or capricious appetite, vomiting, diarrhœa, soiling of the tail, pallor of the sunken eyes and mouth, and gradually encreasing debility. In the worst cases death may occur in a month, in others there are alternate improvement and aggravation, while in some a complete recovery may be made.

The *diagnosis* is based on the gradually advancing character of the disease, the fact that other cats or dogs, in the same environment, suffer, on the black, liquid, offensive condition of the fæces, and above all on the presence of the uncinaria or its eggs in the discharges. The worms are especially likely to be found by sedimentation after the use of vermifuges (see under Uncinaria Cernua).

Necropsy shows more or less catarrhal enteritis and the presence

of the worms in the duodenum, their color varying with the quantity of blood imbibed. The watery state of the blood and extremely anæmic condition of the tissues are very noteworthy.

Treatment is the same as for the same affection in the dog, the agents being given in about ¼ the doses.

Prevention in either genus of animal demands the extinction of the parasite in the other.

Trichosoma Lineare. This was found by Leidy in the small intestine of the domestic cat. The *male* was 3.8 mm. long by .21 mm. broad; the *female* 7.6 mm. long by .35 mm. broad. Body filiform and almost equally attenuated at both ends. Caudal extremity of the *female* coiled in spiral, terminating obtusely and bearing two conical elevations on the ventral surface. Caudal end of the *male* spiral, conical and acute.

Spiroptera Sanguinolenta. At Alfort Veterinary School a specimen of this is labelled as from the cat's intestine.

Ollulanus Tricuspis. The embryos of this worm are found free in the bowels when the mature worm is encysted in the mucosa.

PARASITES OF THE INTESTINES OF RABBITS.

Saccharomyces Guttulatus. Coccidian enteritis. Hexamita Duodenalis. Cestodes: Comb-shaped tænia: T. Rhopaliocephala: Dipylidium Leuckarti: D. Pectinatum: D. Latissimum: T. Wimerosa. Echinorhynchus. Oxyuris Ambigua: Rabbit and hare; colon and cæcum; pointed tail; 3 to 11 mm. long. *Striped Strongle:* Has longitudinal striæ; pointed tail; in cæcum, colon and stomach. *Retort-shaped Strongle: Trichocephalus Unguiculatus:* In cæcum and colon. *Anguillula.* Holostoma Erraticum.

Cryptogams. Saccharomyces Guttulatus is found in the intestine, as in that of ox, sheep and pig, growing in the contents, in the follicles of Peyers patches and in the mucosa around the glands of Lieberkühn.

Sporozoa. Coccidium Oviforme grows in the intestine of the rabbit, producing coccidian enteritis (see vol. II, p. 266).

Infusoria. Davaine describes **Hexamita Duodenalis** in the contents of the bowel, probably **Lamblia Intestinalis** (Neumann).

Cestodes. In the small intestine of the tame and wild rabbit and hare, what was formerly described as the **Comb-shaped Tænia (Tænia Pectinata)**, has been divided by Riehm into five species—two with unilateral genital pore, **T. Rhopaliocephala** of the hare and rabbit respectively; and three with bilateral genital pores, **Dipylidium Leuckarti of wild rabbits, D. Pectinatum of hares,** and **D. Latissimum of wild rabbits.** Neumann adds **T. Wimerosa of wild rabbits.**

Acanthocephalus. An **Echinorhynchus** was found by Bellingham in the rabbit.

Nematodes. Oxyuris Ambigua. Passalurus A. is found in cæcum and colon of rabbit and hare. Body fusiform, of uniform thickness to near the tail when it suddenly narrows and tapers to a fine point. *Male* 3 to 5 mm. long, *Female* 8 to 11 mm.

Strongylus Strigosus. Striped Strongle. This is characterized by the appearance of longitudinal striæ, caused by the shining through of the digestive and other organs, and by the rapidly narrowing and pointed tail. It has been found in the cæcum, colon, and stomach of rabbits wild and tame.

Trichostrongylus Retortæformis. Strongylus R. So named because of its minimum size (trix hair), inhabits the intestinal canal of hares and rabbits, and together with its unsheathed larva, and ova can be found in the fæces. The larva from the fæces of one rabbit fed to another developed to maturity in one month. In cultures on the other hand the larva survived for ten months without further development.

Trichocephalus Unguiculatus. Whipworm of the Rabbit. Like other whipworms this infests the cæcum and to a less extent the colon, and is found in tame and wild rabbits and hares. Its length is 3 to 4 cm., and it is characterized by the tenuity of the spicula covered by a smooth sheath.

Intestinal Anguillula of the Rabbit. This small hair-like worm .37 mm. long has been found in the duodenum, jejunum, and anterior part of the ileum of rabbits. The œsophagus which occupies the anterior fifth of the body is triangular in outline, and gradually expands posteriorly. The ovary is double and the vulva toward the posterior part of the body, is surrounded by papillæ. Eggs ovoid, 40μ by 20μ.

Holostoma Erraticum. Body flat, white, modified to brown

when filled with eggs; 6 to 8 mm. long; terminal oral sucker, median ventral sucker and, while immature (larva) two lateral suckers between these points. Larva free or encysted in molluscs in fish, and even in sporocysts of distomata. The mature fluke infests the intestine of the duck.

PARASITES OF THE INTESTINES OF BIRDS.

GALLINACEÆ.

Among the more injurious parasites of the bowels of chickens the following deserve to be named:

Aspergillus Fumigatus: Already described.

Coccidium Tenellum: Already described under *Entero-hepatitis, white diarrhœa*, etc.

TÆNIÆ. **Tænia (Choantænia) Infundibuliformis** is remarkable for its long, armed rostellum, its small sucking discs, short neck, and its triangular or funnelshaped, ripe segments, the anterior end being narrow and the posterior broad. Genital orifice single and irregularly alternate. It is 20 to 130 mm. long, and 1 to 2 mm. broad. *Larva* in house fly (musca domestica) and earthworm (Grassi and Rovelli).

This infests the intestines of chickens often in great numbers producing diarrhœa, low condition and marasmus.

T. Cuneata. Dicranotænia Sphenoides. *Wedge-shaped Tapeworm.* Has the general appearance of the *infundibuliformis* in rostellum and wedge shaped proglottides. Suckers oval, narrow. It infests the hen, and has its larval form in the earthworm (Allobophoro fœtida) (Grassi and Rovelli).

T. (Davainea) Proglottina. This tænia, which infests the duodenum of the hen, is remarkable for detaching its proglottides as soon as they are formed, so that these actively moving segments may be found in great numbers in the intestinal mucus and contents. The tænia itself is to be obtained by scraping the infested mucosa. From 2 to 5 segments only are attached to the head. The rostellum has about 80 hooklets. The ovum contains a very active embryo, which finds its larval home in snails (Limax cinerus, L. agrestis, L. variegatus) (Grassi and Rovelli). The larva attains maturity in the fowl in 8 days.

T. (Davainea) Cesticillus. This is a *common* variety 9 to 100 mm. long, with very short rostrum, at first armed with 208 hooklets, which are very early shed. The neck is obliterated, the first segments being broader than the head. Last segments nearly square. Genital pore is single and irregularly alternate.

T. (Davainea) Tetragona. Head small, quadrangular, the sucking discs having each a row of 7 or 8 hooklets. Rostrum with a crown of 200 hooks in two rows. Neck long; first segments very short, mature segments quadrangular, imbricated. Genital pore, single, unilateral, in the middle of the lateral border. Length variable 9 to 90 mm. (Molin), 200 mm. (Krabbe). This is a parasite of chickens and may be quite destructive.

T. (Davainea) Echinobothrida. This is characterized by hooks on rostrum (100), and sucking discs, the latter flattened like thorns of the rosebush, and longest in middle rows. The rostrum is flattened and concaved (infundibuliform). No neck. Length 50 to 100 mm., breadth 2 mm. Genital pores, lateral, irregularly alternate. Infests the hen.

T. Malleus. T. Fasciolaris. Head small. Rostrum short, slender, with 12 hooklets. Neck short followed by dilation in which the division into segments is marked by indefinite transverse striæ. Length 40 to 200 mm. Infests the duck and, less frequently, the chicken.

T. Exilis. Head tetragonal, 60 mm., with rostrum short, flattened, and armed with 60 hooklets, in a single row. Suckers round. Distinct neck. Segments broader than long, and narrowed in front so as to give a dentated lateral border to the worm. Genital pores unilateral. Length 100 mm., breadth 1 to 2 mm. Infests chickens.

Bothriotænia (Bothriocephalus) Longicollis. Head small, claviform. Two sucking discs as elliptical, lateral pits. Neck long, slender, with transverse striæ, at first quadrangular, then elliptical segments. Genital pores single in the middle of the lateral border. Length 18 to 27 mm., breadth 4 mm. Infests hens.

Symptoms of Tæniæ in Birds. Dullness, anorexia, emaciation, anæmia, weakness, stiffness, straddling, unsteady walk, diarrhœa, convulsions, and finally a general extension in the flock, and proglottides in the fæces.

Treatment of Tæniasis in Birds. Feed powered Areca Nut or pomegranate root bark (10 grains daily) in the food.

Prevention would include a change of poultry house, yard and run, the avoidance of raw vegetable food from infested grounds, and the restriction to water from deep closed wells, or that which has been boiled.

TREMATODES. **Monostoma Caryophyllinum.** Elongated body, 40 mm. by 1.12 mm broad, slightly flattened with edges slightly creased in front; expanded in front, with a large rhomboidal mouth beneath. Inhabits the intestine of the stickleback and found in the bowel of a duck (Guett).

Monostoma (Notocotyle) Verrucosum. Body white or reddish, 2 to 6 mm. long by .7 to 1.5 mm. broad, narrow in front, expanded behind, with 36 to 47 rounded reddish papillæ (warts) on its venter. Vulva close behind penis which is furnished with minute spines. Ova elliptical, 23μ long with filiform, polar appendage 160μ long. Found in intestine of duck and chicken.

Distoma Oxycephalum. (Pointed head). Body oval, flattened, 6 to 8 mm. long; head pointed and spinous; oral sucker unarmed; ventral sucker large. Dujardin and Von Linstow hold to be a variety of *D. Echinatum.* Infests the duck and hen.

D. Dilatatum. Body elongated, flattened, 4 to 8 mm. long by 2 mm. broad. Constricted anteriorly into a neck with a median dilatation. Probably a variety of *Echinatum* (Zeder). Infests the hen.

D. Lineare. Linear, flat body, rounded behind, 10 to 15 mm. long, 1.5 mm. broad. Oral sucker with 6 papillæ. Infests the rectum of the hen.

D. Armatum. Head semilunar with two rows of spines, and set on a conical neck; oral sucker oval; ventral sucker larger, at the base of the neck; body linear, flattened, rounded behind, concave inferiorly, and except in the caudal part, covered with closely set spines. Length 8 mm., breadth 1 mm. *Habitat* in cæca and rectum of hen.

D. (Cephalogonimus) Ovatus. Body ovoid, thick, and caudad flattened, whitish, with black spots. 4 to 7 mm. long. Oral sucker terminal, round. .4 to .6 mm. wide. Ventral sucker 1 mm. Skin studded with retrossal spines, very dense in front.

and deciduous, leaving the mature worm smooth. Found in the Bursa of Fabricius of chickens and other birds.

D. (**Mesogonimus**) **Commutatum** (**Dimorphus**). Body white, flat, ovoid, 7.5 mm. long, by 1.5 mm. broad in front and 2 mm. behind; orbicular suckers large, genital openings on ventral surface behind the posterior sucker. *Habitat* in the cæca of hen.

NEMATODES. **Heterakis Papillosa** (**Vesicularis.**) Lips in three lobes as in ascarides. *Male* 8 to 9 mm. long; two spicula, unequal sizes; pre-anal sucker with peripheral projecting ring, tail attenuated, awl-shaped. *Female* 11 to 15 mm., gradually attenuated toward the tail. *Habitat* in cæca, often present in large numbers.

Heterakis Differens. Larger than papillosa; lips effaced; distinct pharangeal bulb; two equal spicula, and one smaller; tail of female sharply pointed. *Habitat.* Cæca and rectum, hen.

Heterakis Perspicillium (**Inflexa.**) Body of a dirty yellow, tail ends in a sharp point; *Male* 3 to 8 cm.; *female* 12 cm. long. *Habitat*: small intestine, hen, turkey, peafowl, pheasant. Has caused destructive epizootics.

Heterakis Compressa. Body flattened; *Male* 5 cm. long; *female* 9 cm. long. Found in the intestines of chickens in South Australia.

Trichosomum Collare. Head as a truncated cone. *Male* 8 to 10 mm. long; *Female* 9 to 12 mm. Sheath of spiculum covered with bristles. Present in great numbers in cæca and colon of chickens.

T. Annulatum (ringed). Body white, hair-like, very narrow in cephalic end, marked with close, annular striæ. *Male* 15 mm. long; *female* 80 mm. long. *Habitat*: Intestine of chicken.

T. Retusum. *Male* 13 mm. long; *female* 19 mm.

TURKEY, GUINEA-FOWL, PEACOCK AND PHEASANT.

Coccidium Tenellum, the cause of *entero-hepatitis* in turkey and chicken, and of other invasions of the intestines in these and other birds has been already described. The *turkey* harbors in its intestines the *Distoma Commutatum*, the *Heterakis Papillosa* and *H. Perspicillium* already described as infesting the chicken, and the guinea-fowl and peacock the *H. Papillosa*.

Pheasants suffer extensively and fatally from *Coccidium Tenellum* (Avium) and no less from *Tænia Infundibuliformis*, *T. Cantaniani*, *T. Cesticillus*, *var. Phasianorum*, *Heterakis Retusum*, *H. Papillosa*, and *H. Vesicularis*.

Tænia Cantaniani. This parasite of the turkey has a globular head, unarmed or having deciduous hooklets, with very specious sucking discs, without any neck, but having the first segments bellshaped, and the succeeding one trapezoid. Its length may be 14 mm.

In a number of instances fatal epizootics have come from the presence of one of these parasites, or a mixed form of several species, and it may be safely assumed that with the presence of the parasite and conditions favorable to its encrease a destructive pest may be expected.

The generally applicable measures for the limitation of parasites, adapted in each case to the life history of the offending parasite, will give excellent results. As *vermifuges* give 1 grain calomel to each bird, 5 grains of Areca nut, 10 grains of Kousso kamala, pomegranate root bark, or wormwood. These may be mixed with the food (mush, bread), or administered in pill form. Baronio made a decoction of equal proportions of male fern, tansy and savory about 300 grammes to 1½ litres water, which he mixed with flour and administered in pill form. One of the best resorts is to mix powdered areca nut with flour and make into a dough to be fed to the animals, in such proportions as will give each about 5 grains.

PIGEON.

INFUSORIA. *Trichomonas Columbæ*, alone or associated with coccidia has proved very destructive to pigeons (Rivoltą). The parasite was 6 to 7μ long by 3μ broad, pale, oval, with a median constriction, and four flagellæ, two of the longest attached to the same end.

COCCIDIA. *Coccidium Tenellum* (*Avium*, *Pfeifferi*,) attacks the intestine of the pigeon, as it does that of the chicken and turkey with fatal results. The symptoms are inflammation of the mucosa, with degenerative changes, diarrhœa, impaired appetite, dullness, apathy, weakness, and emaciation. It must be dealt with, as with coccidiosis in the large bird.

CESTODES. *Tænia* (*Davainea*) *Crassula*. Length 12 to 15 inches, breadth 4 mm. Head oval; rostellum rounded at the end, with a double row of 60 hooklets. Neck long and narrow. Segments short but expanded borders. Genital pore unilateral. Eggs large, ovoid, 28μ long and collected in groups. Found in African pigeon in Brazil (Olfers).

TREMATODE. *Distomum Columbæ*, found in the congested small intestine of a pigeon by Mazzanti, is supposed to be Distomum Commutatum.

NEMATODES. **Heterakis Maculosa. H. Columbæ.** Body white, partly translucent, narrowed toward each end. Mouth terminal, trilabiate. *Male* 16 to 25 mm. long; tail finely tapering and sharply pointed; copulatory sucker round with ten papillæ on each side; 2 spicula. *Female* 20 to 35 mm.; tail conical, pointed; vulva in middle of the body. Ova 80 to 90μ long, 40 to 50μ broad.

Common in enormous numbers in intestine, causing dullness, torpor, inappetence, diarrhœa, anæmia, emaciation, wasting, convulsions and death. The mucosa is congested, bloody, swollen and covered thickly with mucus. Besides the worms, great masses of ova are found.

Unterberger estimated that 12,000 ova passed daily in the fæces. On damp blotting paper they formed well grown embryos in 17 days, and transferred to the pigeons' bowels developed into mature ovigerous worms in 3 weeks. When first passed in the fæces they were incapable of living in the bowels.

Treatment is by 1 grain calomel in pill, or 15 grains areca nut powder. Or kousso, kamala, or wormwood may be substituted.

Prevention would require the exclusion of strange pigeons, the seclusion in a pure dovecot and yard of all unaffected birds, as shown by the absence of ova in the fæces, thorough cleanliness, frequent whitewashing of floors, walls, roosts, nests and other exposed places, the avoidance of all food and water that has been open to contamination, or the boiling of the same and the exclusion even of wild birds. The source of danger is preëminently in the fæces which should be heated or kept apart from all places frequented by pigeons, and from sources of drinking water.

Trichosomum Tenuissimum (**Calodium T.; Trich. Columbæ**). Easily diagnosed by its source and the hair-like

attenuation of the caudal end of the body. *Male* 10 mm. long; tail 4.7 mm.; and obliquely truncated. Spiculum with transverse ridges. *Female* 18 mm. long. Caudal, hairlike portion 11 mm. Vulva with a projecting membranous appendix, at the anterior end of hair-like part.

This parasite has been the cause of fatal epizoötics with much intestinal inflammation, diárrhœa, anæmia, emaciation and marasmus. It may be treated like heterakis.

Strongylus Quadriradiatus. Found by Stevenson in large numbers in the pigeon's intestine. Body red, delicate, filiform; *Male* 9 to 12 mm. long. *Female* 18 to 24 mm. Cephalic end enlarged by a vesicular swelling of the cuticle, terminated by a round unarmed mouth. Body with longitudinal markings on the skin. Male has a bilobed copulatory membrane and two long spicula each trifid at its distal end, and both enveloped in an extensile membranous structure with 4 rays from which the parasite takes its name—*quadriradiate.* The tail of the female forms a blunt point bearing a short spine. The anus is 40 microns from the end of the tail, the vulva 5 mm.

When abundant, this parasite causes much intestinal disorder, catarrh, profuse diarrhœa, and emaciation. It may be treated like the heterakis.

Filaria Clava. Von Linstow records this parasite as infesting the intestine, though it is more common in the cervical connective tissue.

DUCK.

COCCIDIA. **Coccidium Tenellum (Avium).** This has been found in the duck's intestine by Zurn, Railliet and Lucet, as nodules. In Zurn's cases it seemed to be the cause of weakness, wasting, diarrhœa and death. Morse found it constantly present in the intestines of ducklings suffering from "leg weakness," and there is no reason why it should be less injurious in the palmiped than in chickens, turkeys and pigeons.

CESTODES. **Tænia (Choantænia) Infundibuliformis.** Rudolphi and Bellingham claim to have found this parasite in the duck's intestine.

T. Malleus. Frequent in the duck. For description see Gallinaceæ.

T. Drepanidotænia Anatina. 12 inches long, 3 mm. broad. The rostrum has a single row of 10 hooklets, with specially long handles. Genital pores unilateral. Eggs ovoid. Embryo long.

T. Drepanidotænia Sinuosa. 2 to 6 inches long (12 inches Rud.). Head with rostrum bearing a row of 10 hooklets like those of anatina. Very delicate neck. Genital pores unilateral. Segments marked by a row of black points indicating the round cirrus pouches.

Very common in the duck in certain localities (Dujardin).

T. (Drepanidotænia Gracilis). 10 inches long; 1.5 to 2 mm. broad. Head round. Rostellum with a row of 8 hooklets, 67 to 80μ long, and with long handle. Neck and anterior part of body very delicate. First segments infundibuliform, then nearly square. Genital pores unilateral. Larva in body of a crustacean (condona rostrata) (Scott, Blanchard).

T. (Dicraniotænia) Coronula (dikranos two pointed). From 1.5 to 7 inches long, 2 to 4 mm. broad. Head rhomboid. Rostrum thick armed with 18 to 26 hooklets, in single row, 14μ long, and having their guard longer than the handle. Genital pores unilateral. Found by Dujardin at Rennes and by Krabbe in Denmark.

T. Megalops, 16 inches long: head large, quadrangular; suckers large, Nitzsch found no hooklets; segments short, ripest ones wedgeshaped with sharp posterior angles.

T. (Mesocestoides) Imbutiformis: 10 to 12 mm. long; no neck; first segments linear, next bellshaped, ripe ones quadrangular; genital pore elliptical. Found in Italian duck by Polonio.

TREMATODES. Three trematoids of the duck have already been described **Monostoma (Notocotyle) Verrucosum,** and **Distoma Oxycephalum** under **Gallinaceæ,** and **Distoma Echinatum** under *Dog*.

Monostoma Caryophillinum was found by Gurlt, in the bowel of a duck at Berlin, but as it is a common parasite of the stickleback, it probably was swallowed by the bird in eating that fish, and is not a true parasite of the duck. It is characterized by its size, 40 mm. long, by 1.12 mm broad, very thin, with notched border, especially in front.

ACANTHOCEPHALA. **Echinorhynchus Polymorphus.**

Body, orange red, round, tapering toward the head, and less rapidly to the tail. Head shows a neck-like constriction, beyond which it bulges into a round or ovoid proboscis, protractile and retractile and bearing about 8 rows of recurved hooklets. The whole body is at first covered by hooks, but these are gradually shed, first in the posterior part and later more forward until in the mature worm none remain. The length varies from 4 to 25 mm. Ova 20μ by 10μ and when ready to open contains an orange red embryo 61μ by 14μ covered with fine spines, and with two larger hooks at each end. This embryo enters the body of the fresh water shrimp (Gammarus pulex) where it passes its larval stage (Greef). At other times it enters the cray fish (Astacus fluviatilis) and passes its larval stage in this host (Von Siebold). The duck eats the infested shrimp or cray fish and develops the echinorynchus to maturity.

Echinorynchus Filicollis. Body 7 to 30 mm., white (male) or yellowish white (female); rostrum with 216 hooks in 18 rows.

Echinorhynchus Sphærocephalus. Body 6 to 17 mm. long; head spherical with a very variable number of hooklets; neck filiform and free from hooklets.

The *treatment* of these acanthocephala in ducks does not differ from that required for other parasites of the intestine.

Prevention is much more important and here a knowledge of the life history of the parasite is an indispensible prerequisite. Ducks, like other waterfowl are greatly exposed to parasitic infestment, as the marshes, springs, pools and ponds which they frequent, are very favorable to the preservation and transmission of the embryos and young parasites, and of the fishes, batrachians, crustaceans and molluscs that supply many parasites with a temporary home in which to pass through their larval stage. In this case we have to deal with the above named crustaceans and molluscs and if these are already present in great numbers, and largely infested, in a circumscribed marsh or pond, it becomes essential to exclude the susceptible waterfowl from such centre of danger. They may be shut up in enclosures sufficiently far from the infested area to ensure that infested invertebrates cannot reach them through drainage, inundations, drinking supply or food. The carriage of such larval hosts by rapacious

birds or mammals must be further guarded against, since with favorable conditions of the locality and the presence of a sufficient number of vertebrate and invertebrate hosts, it becomes easy to plant the offending parasite in a new locality. Wild waterfowl which go and come are to be particularly guarded against. When it is possible to salt the infested pond, so as to render it uninhabitable by the fresh water shrimps and cray fish an early success may be secured in this way. In running streams and lakes, well stocked with fish the depredations of the latter on the crustaceans may keep the danger within bounds. If no such method is available, we can fall back on the plan of raising the ducks indoors, or in a yard with a good paved or cement floor which will not be invaded by the invertebrate hosts. In any case with a flock already infested, the droppings of the ducks must be carefully burned or treated with a caustic (sulphuric acid, mercuric chloride, iron sulphate) to destroy the eggs and embryos. Such measures thoroughly carried out, must clear the locality of the parasite since a new generation cannot be produced without the mutual concurrence of the invertebrate and vertebrate host.

NEMATOIDS. **Ascaris Crassa. The Thick Ascaris. Ascaris Anatina.** Body, of a dull reddish white, thick in the centre and tapering toward each end. *Male* 12 to 15 mm. long, by .5 to 1 mm. broad ; *female* 50 mm. long by 2 mm. thick. Tail conical, thin and sharply pointed. Two long spicula, with expanded base and two membranous sheaths ; vulva somewhat behind the middle. The characteristic thickness of the body is noteworthy and has secured the name. It is abundant at Caen (Deslongchamps) at Rennes (Dujardin), and elsewhere (Megnin).

Heterakis Papillosa, already described in chickens, was found by Von Linstow in ducks in Turkestan.

H. Lineata also found in Turkestan ducks (Von Linstow) has been found by Cock and Schneider in a Brazilian duck. It has a yellow body, 6 to 7 cm. long in the *male* and 9 to 10 cm. in the *female*. It has a slightly developed pre-anal sucker with 11 papillæ on each side. The nematoids must be treated as in the chicken or turkey.

GOOSE AND SWAN.

INFUSORIA. **Trichomonas Eberthi** is found in the intestine of geese as well as of chicken and duck.

COCCIDIA. **Coccidium (Avium) Tenellum** infests geese to a most destructive extent killing one third of the flock in a few days (Biernacki). There are apathy, languor, inappetence, ardent thirst and profuse diarrhœa, the fæces being bloody and containing masses of coccidia in the form of grayish nodules. The odor is offensive. The intestinal mucosa is studded with similar grayish nests of coccidia. The cases responded favorably to ferrous sulphate and glycerine in the drinking water.

CESTODES. All tænia so far found in the tame goose have been alloted to the *Drepanidotænia* (drepane sickle) because of the long sharp nature of the hooklets on the rostrum, arranged in a single row of 8 or 10.

T. (Drepanidotænia) Sinuosa has already been described as a parasite of the duck.

T. (Drepanidotænia) Lanceolata. Body 3 to 13 cm. long, 5 to 18 mm. broad. Breadth encreases from before backward, till close to the tail where a slight lateral shrinkage takes place. Each lateral border slightly serrated by the overlapping of each segment by the one in front. Head small, oval, and bears a single ring of 8 hooks (Krabbe), or 10 (Dujardin) with long blades. Neck absent or indistinct. Genital pore unilateral. This is very common in the goose, causing serious epizöotics (Frisch).

T. Drepanidotænia Fasciata. Banded T. Body 20 to 30 cm. long 1 to 2 mm. broad. Segments short and broad, each marked by a continuous median, longitudinal band from which it takes its name. Head tetragonal, obscurely hemispherical; rostrum long, thick and cylindroid with 8 or 10 long sickle-like hooklets. Neck twice as long as the head. Infests both goose and swan.

T. (Drepanidotænia) Setigera. Body almost 8 inches long, 2 to 3 mm. broad. Head spherical, rostrum long and retractile, armed with 10 long sharp hooklets. Neck short but distinct. First segments mere lines, later infundibuliform with prominent posterior angles overlapping the succeeding segments. Genital pore close to anterior angle. Penis thick and covered with spines, whence comes its name (saetiger bristle bearing).

T. (Drepanidotænia) Tenuirostris. Body 3 to 8 inches long, 1 to 3 mm. broad. Head nearly globular with delicate rostrum bearing 10 long hooklets. Segments have prominent posterior angles, giving the lateral border a serrated appearance. Found in tame duck. Larva supposed to live in the fresh water shrimp, and in Cyclops agilis and pulchellus.

T. Æquabilis and **T. Cygni** are found in the intestines of the swan.

Treatment. This does not differ from that given in tænia to other birds. Powdered areca nut, or pumpkin seeds may be mixed with the food, or one or a combination of the following may be resorted to: santonin, wormwood, absinthe, crushed onion or garlic and male fern.

Prevention is however much more important, and all geese or swans must be separated from any infested place, swamp or water, and kept if need be indoors or in a paved yard, every attention being given to exclude infested food or water, questionable food products brought by rapacious birds or mammals, dangerous drainage or inundations, and the introduction of birds from infested places.

TREMATOIDS. The following species are found in the goose: **Monostoma Verrucosum, Distoma Oxycephalum, Distoma Ovatus** (See under *Gallinaceæ*), **Distoma Echinatum** (See under *Dog*).

ACANTHOCEPHALA. **Echinorhynchus Polymorphus** infests the intestine of both goose and swan (see under *Duck*).

NEMATOIDS. **Heterakis Dispar.** Found in Cæcum of the goose. Mouth with three small lobes. Two lateral wings on the neck becoming narrower toward the tail. *Male* 12 to 18 mm. long, becoming very slender in the tail which ends in a sharp point; pre-anal sucker salient; ten papillæ; *female* 16 to 23 mm. long; vulva in middle of the body. Probably identical with *H. Papillosa* of chickens.

Strongylus Tenuis. From intestine of goose. Body dentated on the border. Three small buccal papillæ. *Male* 6.5 mm.; two equal spicula; large bilobed copulatory membrane, with many rays, two of which are curved forward and hook like. *Female* 7.3 mm. long, sharp pointed tail, vulva near the posterior end of the body. Rare.

Trichosomum Brevicolle. Anterior thick portion short, relatively to the filiform caudal portion. *Male* 10 to 12 mm. long; *female* 20 to 24 mm. long. Found in intestine of 18 geese out of 139 examined at Vienna.

Filaria Cygni was found in great numbers by Redi in an emaciated swan.

Infestment by these worms in goose and swan is liable to be extensive, owing to the aquatic habits of the birds and hence epizoötics are not uncommon. These must be dealt with on the same general plan as in Gallinaceæ, Pigeons, and Ducks.

PARASITES OF THE SEROUS MEMBRANES.

Parasitic invasion of the serosæ is liable to take place in every case when an entozoon or entophyte, entering the system by the alimentary canal or skin, migrates to a distant part of the body and especially when it avails of the blood vessels and the blood current as a means of transportation. Some of these it is true are only present in the serous membrane because they are traversing the blood vessels that ramify in its substance, and their presence is therefore very transient. Others however encyst themselves in its substance and make a longer residence during which they pass through their larval stage. Others again make their abode in the tissues, and there attain sexual maturity and propagate their kind.

The following may be present in the serosa as embryos, but pass their more mature life in other parts and will be described elsewhere in connection with such habitat: *Aspergillus* (birds, cattle, man), *Actinomyces*, *Coccidia*, *Balbiana gigantea* (ruminants and pigs), *Sclersostoma equinum* and *tetracanthum* (equines), *Oxyuris curvula* and *mastigodes* (equines), *Strongylus contortus* and *other strongylus* (ruminants, equines, etc., *Uncinaria radiatus* and *cernuus* (ruminants), *U. trigonocephala* and *stenocephala* (canine), *Trichosomum plicata* and *felis* (dog and cat), *Filaria mansoni* (fowl), *F. medinense*, *lachrymalis*, *palpebralis* and *reticulata* (equines), *F. lachrymalis bovis* (cattle), *F. irritans* and *hæmorrhagica* (equines), *F. trispinulosa* and *immitis* (dog), and

F. Anatis (duck). *Linguatula* (ruminants, equines, rodents, felines and canines). Numerous *cestodes* and *bothriocephalida* in embryo form. Among *trematodes* in the embryo form, *Agamodistomum* (swine), *Paragonimus Westermannii* (man, dog, pig, cat, tiger), *Distoma Texicanum* (ox), *D. Sinense* (man, cat), and *D. Hepaticum*.

Bilharzia crassa which passes its mature existence in the blood of the ox is liable to be found in all vascular parts of the body.

The *larval* forms of œstridae have been found in the peritoneum and even in the arachnoid (horse, ox), but this is merely an instance of a wandering parasite having lost its way. This is not the true winter home of the species.

The following at times invade the peritoneum or other serosæ and maintain a more persistent parasitism, usually for their larval stage: *Symplectoptes cysticola* (fowls), *Echinococcus* (herbivora, omnivora, carnivora). *Cysticercus tenuicollis*, (herbivora, omnivora, carnivora), *fistularis* (horse), *saginata* (cattle), *cellulosa* (swine, dogs, man), *pisiformis* (rodents, birds), *fasciolaris* (rodents), *Bailleti* (cat, dog), *Cœnurus serialis* (rodents), *Œsophagostomata* (ruminants, pigs), *Strongylus gigas* (man, horse, ox dog), *Stephanuras dentata* (swine).

Dithyridium elongatum. *Cysticercus Bailleti.* This parasite was found by Baillet free in the peritoneal and pleural cavities of the cat and has since been seen by a number of other observers in wild carnivora and in rats. Though its mature form has not been traced, it is evidently a *plerocercoid* and probably develops into a *bothriocephalus*. It has a body of variable length, being extensible and contractile, thus it may be 5 cm. long, and in other cases contracted to 1 to 2 cm. Its cephalic end may be as much as 3 mm. and its caudal end no more than 1 mm. With the head introverted the cephalic end shows a longitudinal slit through which with much care the head may be squeezed out and examined. It is irregularly round, destitute of rostrum or hooks, but with four dark colored, round suckers each having a linear slit. The contracted body is thrown into a number of large transverse rugæ or folds, and is studded with cretaceous particles. When extended, on the other hand, it has a vermiform appearance and may be nearly ¾ inch long. When free in the pleural or peritoneal cavity it has been drawn off in numbers in

paracentesis. It has been found as well, encysted in the peritoneum, mesentery, and lungs. When few are present there may be no visible injury, but large numbers cause hydrothorax or ascites. Paracentisis followed by injection of dilute solution of arecolin, pyoktanin, santonin or other nonirritating vermifuge would be in order.

PARASITES OF THE LIVER.

Infections and parasitisms through the portal blood. *Monocercomonas Hepatica:* In pigeon's liver; amœboid, two flagelli, caseated foci pin-head to hazel-nut. *Saccharomyces Guttulatus*, in bile ducts, rabbit, caseous masses. *Eimeria Falciformis:* In rabbit's liver; effects like coccidium oviforme. *Coccidiosis of liver*: Rabbit. *Coccidium Oviforme*: *Eimeria Falciformis. Lesions*: Yellowish white tumors; wheat grain to hazel-nut; dense coat of hypertrophied bile ducts enclosing fatty epithelium and coccidia, *Symptoms*: Poor appetite, lifeless, emaciation, pallor, icterus, unthrifty skin, diarrhœa, ascites; sediment of fæces shows coccidium. Causes a true plague; 90 per cent. in English warrens. *Prevention*: Asphalt floors, clean, dry, plaster, copperas, dry food, segregation; kill, burn sick, scald warrens, copperas, bluestone, sulphuric acid. *Treatment*: Salicylates, hyposulphites, etc. *Coccidiosis of dog's liver. Actinomycosis* in ox and pig; hard, fibrous externally, softer in centre; in common with other abdominal actinomycosis. Diagnosed by presence of other superficial, actinomycotic growths. *Larval Cestodes:* Table of cystic and mature forms. *Cysticercus tenuicollis:* Usually harmless, fatal cases with signs of internal hæmorrhage. *Treatment*, preventive. *Cysticercus pisiformis* in rabbit. *Symptoms* exceptional; emaciation, anæmia, jaundice. *Treatment*, preventive. *Echinococcus in liver: Tænia Fimbriata* in the liver, in deer, sheep; American. Mature 5 to 10 inches long; posterior border of segment fringed, overlapping the next. Distribution: S. America, Mexico, Pacific Slope, Sierras, Rockies, Plains east to Kansas, Nebraska and Missouri. In duodenum and gall ducts of lambs and mature sheep; taken in one summer, are mature and lay eggs the following summer; larval host unknown. *Symptoms:* In end of summer and to January, emaciation, intestinal catarrh, clapped wool, little yolk, debility, paper skin; pendent, fluctuating belly, dropsy, vertigo, irritability, paresis, 'loco.' *Lesions:* Anæmia, dropsy, congested duodenum and liver; young suffer worse. *Treatment:* Arsenious acid, areca nut, thymol, naphthalin. *Prevention:* Keep ewes, lambs and young sheep from old sheep pastures, from wet places, rain-soaked ground and dewy or wet grass, from open ponds, streams or lakes; give water from deep wells in raised troughs, often cleaned and salted; generous feeding, grain from clean troughs; shelter. *Stephanuras Dentatus* in liver; pig; 7 lines to 1½ inch long, encysted with semipurulent debris, causing hepatic congestion, and

degeneration, and constitutional disturbance, which has been taken for hog cholera. *Treatment:* Prophylactic; exclude hogs from infested land, ponds, lakes or streams; water from deep wells, in troughs often cleaned, scalded and salted; keep from abattoirs and their drains and raw products. Avoid large herds in infested districts.

The liver is preëminently predisposed to parasitic invasion on account of its position as the field for distribution of the blood brought from the stomach and intestines by the portal vein. The embryos of parasites taken in with the food, and which afterward make their way into the bloodvessels, tend to make the hepatic capillaries their first resting point, and to penetrate into the liver parenchyma. Another common channel of approach is through the common bileduct.

The diseases resulting from the presence of parasites in the liver are all more or less directly communicated from animal to animal and would thus come especially under the head of sanitary medicine and police, but as the majority do not rise to the importance of a plague, these will be treated of here, as, in the main, demanding private rather than government control.

MONOCERCOMONAS HEPATICA.

This is an infusorial organism discovered by Rivolta in the liver of a young pigeon. It varies from 6μ to 8.5μ in diameter, and through its amœboid movements varied its shape from round, to oval or angular, and moved by the aid of one or two flagelli. Its protoplasm was granular, with two nuclei and vacuoles. The affected liver was firmer than in the normal condition, and contained numerous colonies of the parasite, with necrosed areas varying in size from a pin point to a pea, or hazelnut. These were especially numerous and confluent toward the borders of the liver, and resembled caseated tubercles (caseous hepatitis). The adjacent acini were congested and covered with a gelatinoid exudate.

An attempt was made to transmit the disease by feeding a young pigeon on hepatic pulp containing the living infusoria. When killed six days later numerous cellular bodies, of variable form, and each having a granular nucleus near its periphery, were found in the small intestine, which might be the young monocercomanus, but none could be shown to have as yet invaded the liver.

SACCHAROMYCES GUTTULATUS.

This cryptogam, which has been found in the intestinal canal of rabbit, ox, sheep and pig, has been discovered by Remak in the bile-ducts of the rabbit, where it accumulates in masses of a firm or caseous consistency which might be mistaken for tubercles.

PSOROSPERMOSIS. COCCIDIOSIS.

This is especially common in the liver of the *rabbit*, but has also been observed in man (Gubler, Dressler, Virchow, Leuckart), and, it has been supposed, in swine, though the ovoid organisms found by Johne in the pig's liver were three times the size of the specimens found in the rabbit or in man.

The parasite belongs to the order *Protozoa* and class of *Sporozoa*, and is known as the **Coccidium Oviforme.** It is an ovoid body, flattened at the ends, and consisting of protoplasmic contents, surrounded in the mature condition by a membranous sac constructed in two layers and entirely devoid of cilia, flagella or suckers. As found in the rabbit it is 30μ to 40μ long by 16μ to 23μ broad. Johne's specimens found in the pig were 120μ by 70μ. The parasite is propagated by spores, formed in the interior of the parent organism and set free by the rupture of the cyst. Before the liberation of the spore it is transformed into a falciform body with amœboid movements in the interior of the epithelium of the biliary duct, by which it is enabled to ascend the bile ducts from the intestine, and to enter the biliary epithelium. Balbiani has cultivated the sporocyst in water and moist sand, and found that the protoplasmic contents, which often contract to a globular form within the cyst, will undergo segmentation in two or three days, and that in ten or fifteen days, in summer, the complete evolution will be effected. Segmentation takes place first in two, then four rounded sporoblasts, then each becomes elongated, bends over or swells into a rounded ball at each end, between which the remnant of the protoplasmic spore can be seen. This elongated body next divides longitudinally into two, so as to leave one rounded knob at one end of each, and the resulting falciform body shows amœboid movements and becomes the embryo sporozoön. When evolution takes place in water or damp mud outside the animal body, the spore-bearing cysts ap-

pear to be dried up and carried in the flying dust to be deposited on the food of the rabbit. When introduced into the alimentary canal the cyst is ruptured, and the freed spores in turn liberate the falciform bodies which penetrate the biliary ducts and epithelial cells by virtue of their amœboid movements. The invaded epithelial cell swells out into an ovoid form, which remains for a time adherent by a pedicle, but finally drops off, and they accumulate in grumous or cheesy masses in the dilated biliary ducts. Microscopic examination reveals the real nature of these deposits.

The free sporocysts pass out with the bile into the duodenum and are expelled in the fæces, and undergo development in the damp earth or in water. Thus the parasite comes to abound in the soil of the rabbit warren and the resulting malady becomes a deadly enzoötic. The enormous development, of the sporozoa in the rabbit is further explained by Morot, on the ground that this animal is in the habit of swallowing the fresh balls of fæces and subjecting them to a second digestion.

EIMERIA FALCIFORMIS IN THE RABBIT'S LIVER.

This is another coccidium which has been known as infesting the intestinal epithelium of the mouse, and has been found by Eimer and Rivolti in the liver of the rabbit. It is distinguished from the coccidium oviforme, by the fact that the contents of the cyst, are, in the process of development, converted into a single sporoblast instead of two. Its effects are comparable to those of the coccidium oviforme.

Lesions. These appear as small yellowish white tumors varying in size from a wheat grain to a pea, or even a hazel-nut, projecting from the surface of the liver. Incision shows that these tumors have a dense outer covering of the thickened walls of the biliary ducts, containing adherent masses of the hypertrophied and infested epithelium with free epithelium in process of fatty degeneration or distended by the sporocysts. Free sporocysts are also abundant not only in the thick pultaceous or cheesy contents of the tumors but in the bile. Most of these are ovoid, but others are rounded, with in many cases a dark colored centre, and bear a resemblance to blood globules.

Symptoms. In mild attacks no very marked symptoms are shown, the rabbit, surviving and even maintaining fair condition

in spite of the coccidia. In the more severe attacks there is a gradual loss of appetite, and of liveliness, a progressive emaciation, encreasing pallor of the mucous membranes, with a pronounced icteric tinge, harshness and dryness of the fur, diarrhœa, and ascites. A microscopic examination of the fæces or of the sediment from the water in which they have been washed will detect the sporocysts. The animal falls into a condition of marasmus and dies in about three months.

In England, where the disease was discovered sixty years ago by Sir Robert Carswell, it is still very prevalent, affecting it is said over 90 per cent. of the rabbits. It is most destructive to those that are raised or fattened in confined warrens.

Prevention. This consists mainly in perfect cleanliness of the warrens or cages. A dry wooden floor, or an impermeable concrete one, or still better an asphalt pavement is unfavorable to the preservation and multiplication of the sporocysts and counteracts that repeated autoinfection which renders the disease so deadly. Even these floors should be kept dry, and all fæces should be frequently and thoroughly removed. The liberal use of land plaster containing a small proportion of copperas is a valuable precaution. It is further found that dry food like grain, meal and hay is much safer than a ration of green vegetables on which the coccidia often exist.

When a rabbit warren has become infested a separation of the apparently healthy should be made, and the diseased should be destroyed and their internal organs burned or boiled. The infested cages and floors may be sterilized by boiling water, or live steam from a hose, or they may be sprinkled freely with a saturated solution of copperas, or blue stone, or a solution of one part of sulphuric acid in two hundred parts of water.

Treatment has not been attempted, but it might be tried along the lines of a free exhibition of salicylate of soda, hyposulphite of soda, iodide of potassium, and bitters.

PSOROSPERMOSIS IN THE DOG.

The presence of the psorosperms in the dog's liver has been recorded by Perroncito. On section the liver showed whitish yellow patches along the lines of the biliary ducts. Under the microscope these were found to contain small oviform bodies

with thick walls and granular contents. Apart from this the lesions contained caseated material consisting of granules and corpuscles in a state of fatty degeneration. The resemblance to the psorospermosis of the rabbit's liver was striking, but it remained problematical if it was the same parasite communicated to the dog by the rabbits which he had devoured.

ACTINOMYCOSIS OF THE LIVER.

In damp localities where actinomyces abounds it is by no means uncommon to find it growing in the liver of cattle and swine. Rasmussen has noted a number of cases in which the disease affected at once liver, spleen, peritoneum and intestine. In one year (1890) he saw twenty-two cases of hepatic actinomycosis. Jensen, who has also recorded hepatic cases, describes them as rounded tumors of variable sizes enclosed in a fibrous covering of greater or lesser thickness and somewhat softened in the centre. Microscopic examination detects the club-shaped cells arranged in tufts converging toward the centre. Jensen has found them extending from the liver to the diaphragm, and Rasmussen from the liver into the duodenum.

Symptoms are only the general indication of hepatic disorder. In cases in which the existence of superficial actinomycotic swellings affords a reasonable clue to the true nature of the disease, it may be treated with potassium iodide twice or thrice a day until all symptoms subside.

TÆNIÆ, TAPE-WORMS. LARVAL FORMS.

The larvæ of certain tape-worms infest the liver of different domestic animals and prove more or less inimical to their hosts. As they do not often rise to the importance of a plague they will be properly considered in this connection. These may be tabulated as follows:

Larva or Cystic Form.	*Host.*	*Tænia or Adult Form.*	*Host.*
Cysticercus Tenuicollis	Ruminants, Pigs.	**Tænia Marginata**	Dog
C. Pisiformis	Rabbit, Hare, Birds.	**T. Serrata**	Dog
C. Cellulosæ	Pig, Dog.	**T. Solium**	Man
Echinococcus Veterinorum or Polymorphus	Cattle, Sheep, Goats, Pigs, Deer, Camel, Dromedary, Elan, Antelope, Horse, Zebra, Tapir, Kangaroo, Rabbit, Squirrel, Dog, Cat, Turkey, Elephant, Ape, Man.	**T. Echinococcus**	Dog
Cœnurus, Undetermined Species	Cat	Unknown.	
Unknown.		**T. Fimbriata**	Sheep, Deer

CYSTICERUS TENUICOLLIS IN THE LIVER.

This cystic worm, which is the larval form of the tænia marginata of the dog develops in the various internal organs and serous membranes of the sheep, goat, ox, deer and other ruminants, in the pig and soliped. Though most commonly found under the peritoneum and pleura, they also inhabit the solid organs, and according to the observations of Baillet, they habitually pass through the liver in their progress toward the other organs and membranes. He fed ripe segments of tænia marginata to lamb and kid respectively and on their death in ten days, he found the liver congested and that it oozed blood on the slightest pressure. The liver was found to be traversed by small winding channels filled with clotted blood, except where occupied by two or three transparent globular vesicles (the cysticercus embryos). One kid survived until the twenty-fifth day, when the liver showed complete disorganization, and the peritoneum violent inflammation. In the rapidly fatal cases there was extensive blood extravasation into the abdomen.

A similar fatality has been exceptionally seen in cases occurring casually. Putz reports a fatal hepatitis and peritonitis in a Cow which had an enormous development of cysticercus tenuicollis in the liver. Boudeaux describes a similar occurrence in the PIG with symptoms resembling those of pneumo-enteritis. Leuckhart and Zschokke also draw attention to the occurrence of fatal results in this animal. Others have found the pig's liver studded with numerous cysticerci varying in size from a millet seed (Walley), to a hazel-nut or hen's egg (Semmer).

The *symptoms* in fatal cases are those of internal hemorrhage, encreasing pallor of the mucous membranes, sunken eyes, weak, rapid, irritable pulse and gradually encreasing weakness. With both lungs and liver affected Boudeaux's pig had symptoms resembling those of pneumo-enteritis.

But in a great majority of casual cases the cysticerci are present only in small numbers, and are found only after death and often in fat animals. In such cases the cysts are found more numerously in the peritoneum and other organs, having traversed the liver singly or in small numbers without creating appreciable irritation or symptoms.

Treatment must be mainly preventive, as nothing will save the animal if it devours a number of ripe segments of the tænia and the innumerable eggs which they contain, and if the countless embryos derived from these invade the liver at the same time. The chief precautions are to destroy unnecessary dogs, to cook the food of such as must be kept, and to treat them periodically for tape-worms.

CYSTICERCUS PISIFORMIS IN THE LIVER.

This parasite is the cystic or larval stage of the tænia serrata of the dog. The rabbit, having taken in with food or water, one or more ripe segments of the tænia, or some of the eggs furnished by these, hatches out the eggs in its stomach or intestine, and the six-hooked ovoid embryos boring their way through the intestinal walls and those of the portal vein reach the liver, where they cause emboli and live in the clots which obstruct the vein, as already described of the embryos of the C. Tenuicollis. By the second day after the ingestion of the eggs the presence of the embryos in the liver is manifested by fine, tortuous, red lines and very small white globular bodies at some part of their course. By the fifth day the projecting globular body has acquired the size of a hemp-seed, is easily picked out without disturbing the hepatic tissue, and shows a thick wall enclosing a clear refrangent corpuscle. Laulanié has shown that these lesions consist in the obstruction and obliteration of the portal venous branch by the clot in which the embryo is embedded. The blocking of the veins in animals that survive, entails impaired function and cirrhosis of that portion of the liver which the blocked vein normally supplies with blood. The thickened connective tissue is remarkable for the abundance of dilated capillary blood vessels and for the presence of giant cells (Piana). The giant cells often enclose a minute central clot of blood (Cadeac). They are also often invaded by bacteria (Neumann). In the same way the blood clot surrounding the embryo is colonized by bacteria brought by the parasite from the intestine, and the debris of a dead embryo may be surrounded by a limited formation of pus.

The surviving embryo, at first one millimetre in length, grows rapidly and on the twenty-second day may measure a centimetre long by a millimetre broad. It now becomes constricted in the

centre and gradually divides in two, one of which is disintegrated and absorbed, while the other develops a globular head and forms the cysticercus (Moniez). About a month from its ingestion the cysticercus reaches the surface of the liver, where it may remain attached and hanging into the peritoneal cavity, or it may become detached and float off in the abdomen to form a new attachment to any part of the peritoneum or to any abdominal viscus.

Symptoms. As in the case of cysticercus tenuicollis, symptoms are only observed when a great number of embryos reach the liver at once, or in rapid succession. The rabbit rapidly loses flesh, becomes shrunken and weak, and its mucous membranes are pale and bloodless.

Prevention is exactly as for Cysticercus tenuiformis.

ECHINOCOCCUS IN THE LIVER.

(See Parasites of Intestines in dog).

TÆNIA FIMBRIATA IN THE LIVER. FRINGED TAPEWORM.

The fringed tænia is so named because the posterior border of each segment is split up into an abundant fringe, and when the worm is longitudinally contracted this stands up as a sort of nap giving a velvety feeling to the surface. The parasite appears to be strictly American. It was discovered in 1824 by Natterer in Brazillian deer, and later in several varieties (Cervus paludosus, C. rufus, C. simplicornis, C. nambi and C. dicotomus)

In 1887, Dr. Cooper Curtice definitely ascertained that the great losses from tapeworm among the sheep of the Western Plains, were due almost entirely to the T. Fimbriata. From evidence collected by him, it became plain that this was further the most destructive sheep entozoön of the Rocky Mountain Regions and of the Pacific Coast. Mr. Stewart's parasite from Missouri sheep, described by him as the Tænia Plicata, is evidently the T. Fimbriata, as the former does not occur in the sheep, and the latter closely resembles it in its size and in the shortness of its segments. Dr. Faville had studied the parasite in Colorado, showed its presence in the bile ducts, and attributed to it the losses which had been usually referred to "loco" disease.

Description of T. Fimbriata. The mature tænia is from five to ten inches long by ¼ inch broad. It encreases in breadth from

the head to about ⅔ inch from the caudal end, where it shows a terminal narrowing. The segments are so exceedingly narrow from before backward that when the parasite is contracted the divisions are effaced and the surface has a velvety aspect, but when longitudinally extended the lines of segmentation appear like rather coarse transverse striæ. The head is large, tetragonal and bears a sucking disc on each of its angles. The anterior border of each segment is smooth and convex from above downward and from side to side, the posterior border is concave or cup-shaped, the fringed edges overlapping the next succeeding segment. The fimbriæ are represented by simple crenations on the segments near the head, but on the body and caudal portion of the tænia they are well developed.

The generative organs are represented by two lateral sets of male and female organs in each segment, and each opening through a lateral orifice. The oviducts are filled with eggs which contain live embryos in the terminal segments.

Geographical Distribution. The parasite is found in the deer in Brazil, in sheep of the Pacific Coast, the Sierras, the Rocky Mountains, Mexico, the Plains, and as far east as Kansas, Nebraska and Missouri. Dr. Curtice suggests that it is co-extensive with the distribution of Mexican and Colorado sheep, and therefore an invasion of the Middle and Eastern States is to be feared.

Life History. The young tæniæ are found in the duodenum of lambs and adult sheep of all ages, but the mature tænia has not been seen in lambs of less than ten months old. They are found especially in the gall ducts showing that these constitute the habitat of choice. From the worms found in lambs of different ages the growth seems to be about an inch per month. The tæniæ taken in during one summer appear to reach maturity and furnish embryos the following spring. The embryos pass out with the fæces but their host in the cystic stage has not been discovered. From the varying size of the tæniæ found in the duodenum and bile ducts the embryos seem to be taken in at intervals throughout the year. The intermediate host would seem to live in the water or in the vegetation and might be sought among molluscs or crustaceans.

Symptoms. Toward the end of summer the sheep lose flesh

and go on in November and December to marked emaciation. The head appears large for the wasted body, the wool flattened and wanting in yolk, the skin attenuated from lack of subcutaneous fat (paper skin), there is pot-belly with fluctuation from ascites, or there may be serous effusion under the skin beneath the abdomen, and less frequently under the lower jaw. The sheep moves stiffly, lags behind the flock when driven, and seems to have difficulty in browsing on the shorter grass. They turn and stamp at the dógs more than other sheep and appear paretic and foolish so that they are called "locoed." Faville attributed the "loco" disease to the tæniæ alone, but the poisonous action of the "loco" weeds, Astragalus Hornii, A. Lentiginosus (in California–Vasey), and A. Mollissimus, Oxytropis Lambertii, (in Colorado, New Mexico and Kansas—Ormsby, Whipple, Rothrock, Ott, Watson, Day), on horses and cattle, which do not harbor this parasite, and the experimental poisoning of rabbits, cats, frogs and other small animals by these plants (Day), contradicts such hasty conclusion. Curtice suggests with greater plausibility that the disorder of the liver and digestion by the tænia may cause the sheep to take to eating the "loco" plants and may thus aggravate the general affection or drive it to a fatal issue. The symptoms are in the main those of distomatosis, lung-worms and other exhausting parasitic diseases.

Lesions. The body is emaciated, the subcutaneous and internal fat being replaced by a watery serum. Dropsical accumulations of serum, subcutem, in the abdomen and sometimes in the pleuræ, pericardium, arachnoid or subarachnoid space, are sometimes found. The muscular system is pale and flabby. The gastric cavities often contain masses of leaves of one or other of the "loco" plants, in other cases ordinary ingesta only. The duodenum has congested mucosa and contains many immature T. Fimbriatæ (2 to 30 or even 100, Curtice). These are one line to an inch and upward in length (½ inch in two months lamb, Curtice). The common gall duct and the biliary ducts within the liver contain the more mature worms up to five inches or a foot in length. As in the duodenum, these remain attached to the mucosa by the sucking discs on the head and body of the parasite and extend along the duct toward the intestine following the current of the liquid bile. Sometimes one or two are found in

the pancreatic duct as well. They enter these ducts when small, and as they grow and encrease in numbers they cause distension, so that the enlarged ducts stand out as white bands on the surface of the liver or pancreas, as the case may be. The liver may be the seat of congestion, softening, or other change. The bile has usually the normal greenish yellow color, but when seriously obstructed it may be inspissated. In advanced cases the kidneys are usually pale and flabby.

The lesions vary much, according to the severity of the attack and the stage of the disease. As in the case of other parasitisms the young and immature sheep suffer most, and flock masters feel that they would do well if they could preserve the lambs over the first year of their lives.

Treatment. Therapeutic treatment has been very unsatisfactory. The usual tæniafuges (pumpkin seed, pomegranate root bark, kousso, kamala, male fern, santonin, oil of turpentine) have proved virtually useless. This is, however, equally true in the case of the tænia expansa, and may be charged to a great extent to the certainty almost of the dilution of the tæniacide to complete inactivity through admixture with the ample contents of the first three stomachs. In the case of the tænia fimbriata, there is the super-added difficulty of reaching the mature worms which are deeply secluded in the bile ducts. The most promising treatment, one which might be successfully applied to high-priced sheep that can be kept up and treated individually, is unfortunately inapplicable to the flocks that range at large over the Rocky Mountains and the Plains. Where the value of the animal would warrant it, the administration once or twice a day of one-half to one grain of arsenious acid in solid form, mingled with sodium bicarbonate, would probably act beneficially as it does in the case of tænia expansa. It may be borne in mind that the young tænia, which are most sensitive to toxic influences, are for a time confined to the duodenum, and therefore are as easily reached as the tænia expansa. The arsenious acid administered in the solid form is dissolved slowly and imperfectly as it passes through the stomachs and intestines, yet in sufficient amount to prove poisonous to the tape-worm. By thus cutting off the young worms in the duodenum we should prevent the invasion of the liver. Yet the agent is too dangerous an one to be scattered reck-

lessly in troughs, or still worse, on the soil, in connection with salt or feed which the sheep will voluntarily consume. It is only in the most intelligent and careful hands that such an agent can be trusted. Majowski extols naphthalin one dram twice daily as best. Thymol might be tried as for uncinaria.

Prevention. The effective treatment of this disease must be in the way of prophylaxis. But as yet we are barred from making this as effective as it ought to be, because of our utter ignorance of the intermediate host of the tænia, that which harbors it in its cystic or larval condition. That such a host exists, follows from the fact, that all true tape-worms, the full life history of which is known, pass through the larval and mature conditions respectively in two different hosts. This is fully confirmed for the tænia fimbriata, by the complete failure of Curtice to convey this parasite to lambs by feeding them with the ripe proglottides obtained from mature sheep. When the progress of investigation shall reveal this intermediate host, we shall probably see the way to a perfect and easy prophylaxis, by the destruction of the host of the larva, or by keeping it apart from sheep and from grounds and drinking places frequented by sheep. In the meantime and until such discovery shall be made, we can still apply some rational, though necessarily imperfect measures of prevention.

The pregnant ewes, and particularly ewes and lambs should not be allowed on pastures which have been stocked by sheep the year before. The host of the proscolex, must be taken in by the sheep with its food or water and therefore presumably belongs to some species of small invertebrate animal (Mollusk, Crustacean or other), which lives in water, on fresh vegetation or in the damp surface layers of the soil. These invertebrates as a rule have but a short lease of life and undergo a metamorphosis preliminary to passing the winter. The cystic tapeworm is therefore, usually, only entertained by such invertebrate for a few months, and when set free by its death or metamorphosis, it too must perish unless it can find its way into its next destined host, the sheep. One year's absence of the sheep, or of the unknown host of the cystic worm, from the pasture, and the tænia must perish for want of the appropriate host in which alone it must pass the next stage of its existence. Of course, deer, and any other host of the adult tape-worm must be equally excluded with the sheep. Fencing

the land into two or more enclosures, one of which shall be kept free from sheep, deer, and the drainage of sheep pastures or deer ranges for at least one year before the lambs are admitted to it, must be among the most important measures of prevention. When possible the lambs should be excluded from damp places, and from the whole pasture when soaked by a prolonged rain-storm and when they would tear up the vegetation by the roots and eat it with the adherent earth and invertebrate life. They should also be kept corraled until the vegetation is clear of dew and of infested invertebrates that crawl up on the damp plants.

Then, too, the drinking water must be furnished, not from running streams which may bring down the embryo or proscolex from higher levels that may be infested by the parasite, but rather from closed and cemented wells into which no surface drainage nor small infested invertebrate can enter. The water is best furnished in troughs set above the level of the adjacent soil, so that it may not become contaminated by drainage, or by invertebrate hosts. Such troughs should be occasionally emptied and cleansed, and enough salt should be placed in them at frequent intervals to keep the water moderately impregnated. Salt is inimical to most verminous parasites, and the proscolex and its fresh water invertebrate host placed in a saline liquid are likely to perish before being taken in by the lamb, or later in its stomach or duodenum.

Great care should be taken to fence in or in some way exclude the sheep from ponds of stagnant water which receive the drainage of surrounding sheep pastures.

Less important than the above, though still very valuable, are all measures for maintaining the general health of the lambs and thereby enabling them to survive the weakening effects of the parasites. Artificial feeding during periods of drought and of bare pasturage, and especially in autumn and winter, must not be forgotten. Hay from meadows free from the parasite, and not used the previous season for a sheep pasture, may be fed from racks—never from the ground. Grain fed from clean troughs—never from the ground—is of still greater value.

Protection against cold rain and wind storms, by sheds or even close wind-breaks, will do much to maintain vigor and condition. Finally daily doses of copperas during the trying period may

often serve to maintain the balance of health. If the grain and water can be supplied in iron troughs they may at once furnish a daily calybeate tonic, and avoid the probability of their harboring the cyst-infested invertebrates.

But one more suggestion need be made. In seeking for the host of the cystic parasite, no one seems to have investigated the question of its possible presence in the external parasites of the sheep. Yet the presence of the larva of the tænia canina in the trichodectes latus of the dog suggests a possibility of the discovery of the missing host of the cyst in some epizoön of the sheep. In such a case the true, effective and easy protection will be found in medicated baths or salves which will destroy the epizoa in question, and render the propagation of the tape-worm impossible.

STEPHANURUS DENTATUS IN THE LIVER OF THE PIG.

(See Worms of the Kidney).

PARASITES OF THE LIVER. *Continued.*

Distomatosis: Definition: Flukes in gall ducts. *Cause*: *Distoma Hepaticum*: Flat, leaf-like, ¾ to 1 inch, conical head, terminal sucker, ventral sucker back of neck; body covered with scaly spines inclined backward, bisexual, lateral digestive and water vascular canals; eggs brown, oval, with operculum at one end. *Development*: Ovum, ciliated embryo, brood capsule in mollusc, cercaria free in fresh water, cercaria encysted in glutinous matter on aquatic plants; young fluke free in stomach, duodenum, and gall ducts. Mollusc host limnea truncatula or other soft snail; infests herbivora, especially ruminants, and omnivora. *Distoma Lanceolatum*: 3 to 4 lines, lozenge shaped, skin smooth, ovum with operculum, development like hepaticum. Mollusc host uncertain. *Accessory causes*: Wet seasons, inundations, autumn and spring, undrained, wet ground, deltas, low islands, bottoms, basins, ponds, lakes; salt marshes and salt springs escape, having no fresh water snails; frost inimical; low condition, debility. *Symptoms*: Transient improvement for one or two months, then anæmia, dropsy, emaciation, conjunctiva pale yellow, puffy, infiltrated, paper skin, razor-back, flattened wool, little yolk, dropsy in or under chest or abdomen, and under jaw; leaves flock, pendent head, drooping ears, sunken eyes, easily fatigued, or made breathless, abortions, appetite irregular, ardent thirst, variable bowels, ova in fæces. *Duration*: Cut short by hepatitis or apoplexy, or death in one or two months, or longer. Recovery. *Lesions*: Swelling and congestion of liver; later thickening of walls of gall ducts, with salts in-

crusting their mucosa, anæmia, pallor, dropsy, absence of fat, or of rigor mortis; flukes in gall ducts or bladder, congestion in lungs, etc. Often other parasitisms of lungs, bowels, etc. *Prevention:* thorough drainage to destroy intermediate host; cultivate frogs and toads or, in the rivers and ponds, carp; put infested pastures under a rotation of crops, avoid waters from infested pastures, turn on salt marshes, licks or salted ground, salt freely in food and water; top-dress pastures with lime, avoid overstocking; boil, burn or deeply bury victims; put new purchases on dry, sandy soil or salt marsh; soil sheep, feed generously. *Treatment*: Tonics, naphthalin, picrate of potash, arsenic; generous feeding.

Distomatosis of the Liver. Liver Rot. Fluke disease. Cachexia Aquosa verminosa. Rot dropsy. Cachexia-ictero-verminosa.

Definition. A parasite disease of the liver of sheep and other animals, due to the presence in the gall ducts of two species of trematodes—distoma hepaticum, and distoma lanceolatum, and manifested by progressive anæmia, emaciation, icterus, dropsy and marasmus.

The essential *cause* is the presence in large numbers of either of the parasites, yet in the advanced stages the illness persists, even to a fatal issue, though the distoma has reached the limit of its life and has disappeared.

Distoma Hepaticum. Fasciola Hepaticum. Liver Fluke. This trematode is a flat, leaf-like, brownish parasite, oval, broad in front and narrowing gradually to the tail, which is rounded; length ¾ to 1 inch; breadth 5 to 7 lines. The head is conical with a small, round, oral sucker at its summit. The ventral sucker, just back of the neck, is large with a triangular opening, and just in front of this is the genital orifice. This skin is covered with scaly spines inclined toward the tail. Back of the ventral sucker in the median line is the uterus with the oviducts on each side. Still more posteriorly is a white area representing the testicles and vasa deferentia. The penis is curved and projects from the genital pore. The digestive system is represented by two lateral canals connecting in front with the oral sucker and gullet, and giving off numerous ramifying branches toward the lateral margins of the body. The albuminiferous ducts are placed more laterally and run longitudinally with branches passing out toward the borders of the fluke. The eggs are brown, oval, $\frac{1}{180}$ by $\frac{1}{270}$ inch, with a lid or operculum at one end which opens to allow the exit of the embryo.

Biology. Development. The life history of the trematodes has been especially ellucidated by Steenstrup, Creplin, Pagenstecher, Ercolani, Leuckart, Baillet and above all by Thomas. The parthenogenesis or encrease in numbers by asexual larvæ, and the successive hosts and media of the immature distoma, are as follows :

1. The unsegmented ovum in the oviducts and womb; the segmented ovum in the bile ducts and intestines of the host, or in pools of fresh water.
2. The ciliated embryo (micracidium) swimming free in fresh water.
3. Brood capsule in the body (usually chest) of a mollusc.
4. Redia in parenchymatous organ (usually liver) of a mollusc. In winter one or more crops of daughter rediæ in same.
5. Cercaria swimming free in fresh water.
6. Cercaria encysted in glutinous matter on aquatic plants.
7. Young fluke set free in stomach and duodenum and entering the biliary ducts of a mammal.

The *ova* may number 30,000 to 40,000 from a single fluke, (Thomas, Neumann). When set free in the bile ducts, bowels, or outside in water at 23° to 36° C. they undergo segmentation and develop an embryo which may escape in 3 to 6 weeks by pressing open the operculum.

The *embryo* 130μ by 27μ, is a flattened organism, like a microscopic distoma, being broad in front and narrowed behind, the outline being oval. From the middle of its cephalic or thick end projects a sharp, protractile, conical papilla by the aid of which it bores its way into its victim mollusc. In the anterior part of the body is a dark crucial object (digestive apparatus, Leuckart); the interior of the body contains granular cells, and its cutaneous layer consists of polygonal cells bearing an abundance of cilia, by the aid of which the embryo swims in water with great rapidity. If it fails to find a molluscous host it usually dies in eight hours, though in a slightly alkaline fluid it may survive for three days (Thomas).

The *embryo* coming in contact with a soft skinned mollusc, instantly attacks it, projecting its conical borer into its skin, and rotating its body with great rapidity, alternately elongating and shortening it, until it has completely disappeared in its substance

when it proceeds to encyst itself by preference in the pulmonary space, but also at times in the general body cavity or in a solid organ such as the foot, in which last, however, it usually perishes for lack of room to grow.

The *mollusc* which forms the usual host is the Limnœa Truncatula, a small, soft, gray gasteropod with a shining shell ⅜ inch in length and having 5 turns in the spiral. This is found very abundantly in most parts of the world, up to an altitude of 1100 to 1200 metres. It is absent in salt marshes, and has not been demonstrated in the Shetlands, Australia nor America, although the fluke is present in these three countries. Neumann suggests that the Limnœa humilis may be the host in North America and Limnœa viator in Buenos Ayres, but this has not been demonstrated. It is a remarkable coincidence that the distoma hepaticum and Limnœa truncatula are both practically unknown in most parts of North America. Leuckart obtained encystment of the embryo in the Limnœa peregra but it failed to mature into cercaria. Experiments with a number of other snails have also failed.

On becoming encysted, the embryo sheds its layer of ciliated cells, contracts into an ovoid or rounded mass, and develops within it round clusters of cells. It is now a *sporocyst*. The cell clusters, at first round, become ovoid, then oblong, acquire a delicate cuticle, and at one end an opening which leads into a simple blind digestive sac. Behind the pharynx there is a circular ring, and near the posterior extremity two short obtuse processes. This new organism is called a *redia* (sometimes a *nurse* from its developing cercaria within it). The *sporocyst* reaches maturity, and a size of 0.5 mm. to 0.7 mm. in 15 days in summer or 30 days in autumn. It may contain but one *redia* but usually it encloses two large ones and four to six small ones.

A *redia* having attained the requisite development bursts through the walls of the cyst, which at once closes up and goes on hatching the younger ones. The released *redia* is very active in boring through the tissues of the snail and mostly seeks a home in the liver on which it feeds and tends to destroy the snail in three weeks (Thomas). The *redia* grows rapidly to 1.5 mm., becomes elongated, cylindroid, acquires a mouth and digestive canal, and like the sporocyst develops within it clusters of germinative cells which develop into *daughter rediæ* in summer or *cercaria* in autumn.

The *daughter redia* has a similar organisation to its parent, and like it may develop within it a second crop of *daughter rediæ* or, in other cases, *cercaria*. As there may be in a vigorous snail as many as three or four successive generations of *daughter rediæ*, and as each *redia* develops as many as 15 or 20 in a generation it follows that 1000 cercaria (Thomas) or even 100 times as many might possibly come from a single embryo fluke or sporocyst.

The *cercaria* developed in the redia or *daughter redia* to the number of 15 or 20 are ovoid, show an oral and a ventral sucker, and connected with the former a digestive canal having two branches or cæca, and finally a delicate contractile tail of about twice the length of the body. The body is 0.28 mm. to 0.3 mm. in length and its skin is covered with fine spines. It escapes from the redia by an orifice back of the ring, and actively bores its way through the tissues until it escapes from the body of the snail when it actively swims in the water, using its tail as a propeller. Its life of freedom is, however, very short as it proceeds at once to encyst itself in the submerged vegetation or on that which grows on damp soil.

The *encysted cercaria* is found mainly on the stems of grass, cress, dandelion, dock, etc., where the swimming specimen has fixed itself, lost its tail and covered itself with a glutinous exudation which hardens into a minute white sac. These are usually found on the lower parts of the leaves or stem, so that sheep, which eat close, take in more and suffer to a greater extent than other animals. Sheep with distorted jaws (undershot or overshot) are found to suffer less, as they can not crop the grass short. Yet all herbivora are liable to acquire the parasite and it may possibly be taken from the water as well as the vegetation.

The *cercaria* from the cysts probably enter the gall ducts from the duodenum, and can be found in the small ramifications of these ducts in the liver, rolled upon themselves, the ventral side outward, and the oral sucker attached to the mucous membrane to imbibe the blood (Railliet). Here they acquire sexual organs, male and female in each individual, and grow to their full size in about 6 weeks.

Habitat. The distoma hepaticum infests the gall ducts of herbivora, especially ruminants, and omnivora. The sheep is the greatest sufferer, but they attack also the ox, goat, camel, deer,

elk, stag, antelope, hare, rabbit, great kangaroo, horse, ass, pig, elephant, giraffe, guinea-pig, grampus, and even man. Some immature wondering flukes (Hexathyridium venarum, Distomum oculi-humani,—Distomum ophthalmobium.—Monostomum lentis), are probably young liver-distomata.

Distoma Lanceolatum. Lancet Shaped Distoma. Dicrocoelium Lanceolatum. Smaller than the distoma hepaticum (3 to 4 lines long by 1½ lines broad), the lanceolatum is also more pointed at both ends, but especially the cephalic one, and is covered by a smooth skin. Both oral and ventral suckers are large, the genital orifice is close in front of the ventral sucker, the convoluted uterus and oviducts fill the middle and hinder parts of the body, to which the contained ova give a brownish color, the digestive canal is divided in two non-ramified branches, narrowed toward their blind ends which extend to the caudal fourth of the body. The ova are very numerous, ovoid, brown, $\frac{1}{600}$ inch in diameter, with a larger operculum than the distoma hepaticum. The yolk is often segmented before being laid.

The embryo is globular and is covered with cilia on the anterior third of the body only, and provided with a conical cephalic borer. Its movements are less active than those of the distoma hepaticum embryo. The successive stages of development are supposed to be identical or nearly so in the two species. The moluscous host is, however, not certainly known. The claims for the planorbis marginatus (Willemoes-Suhm) and helix carthusiana (Piana) have been successfully controverted.

Habitat. The *distoma lanceolatum* lives in the gall ducts of the sheep, ox, goat, red and fallow deer, gazelle, llama, rabbit, hare, pig, ass, dog, cat and man. It usually occurs in company with the distoma hepaticum, though in smaller numbers, and it has been held to be much less injurious owing to the absence of cutaneous spines. It has, however, the same blood-sucking habit, and when equally numerous must, in this respect, be correspondingly hurtful.

Accessory causes. From time immemorial *wet seasons* and *inundations* have been observed to coincide with great losses in flocks and herds, and though some of these outbreaks doubtless came from different parasitisms and infectious diseases, yet in the light

of modern experience much was probably due to the liver fluke. Fitzherbert even mentions the '*flokes*' as associated with the dropsies and jaundice as early as 1532. Wet seasons and rot coincided in 1628 (Bottani), 1761–2 (Demars), in 1809–'10–'11 and '12, 90,000 sheep having died in 1812 in Nimes and Montpelier, and 100,000 in Arles (Huzard, Tessier). In 1816–17 it was again most destructive in France and England (Huzard, Tessier, Simonds), and again in France in 1820–'29–'30–'53–'54, and in England in 1824–'30–'52–'53–'60–'62 and '72. In 1824 Mr. Cramp lost $15,000 worth of sheep in the small isle of Thanet in three months (evidence in House of Lords), and in 1830–31 England lost 1,000,000 to 2,000,000 (Ed. Vet. Review). In 1833 the Smithfield, London, sheep market had on each market day 5,000 head less than the former average (Evid. in Ho. of Lords). In 1860 the western and southern counties lost $\frac{5}{6}$ths of their flocks (Simonds) and in 1862, 500,000 sheep perished in the United Kingdom (Gamgee). In 1876 it killed 40 per cent. of the cattle of Slavonia (Neumann), and sheep of the value of 1,500,000 francs in Alsace-Lorraine (Zundel). In 1882 Buenos Ayres lost 1,000,000 sheep (Vernicke). Since 1855, when introduced by imported German sheep, it has prevailed in the damp pastures of Victoria, Australia (Veterinarian), and in 1891 one owner lost more than 10,000 sheep.

The *wet seasons* (autumn and spring) are notorious for the prevalence of the disease.

So with *inundations:* after the overflowing of the Nile the sheep suffer after they advance on the pastures from which the waters have subsided, so that the period following the fall of the river, is the period of 'rot.'

Wet, marshy, undrained pastures, such as deltas, low islands, bottom lands, basins with no dependent outlet, drying ponds and lakes of fresh water are especial homes of the fluke and of resultant 'rot.' The same applies to unimproved clays and other impervious soils in which the water accumulates and remains. In France the damp bottom lands of the Sologne, Berry, Gatinais, and Gascony; in England the fens of Lincolnshire, the Ouse Valley and the sea coasts of Kent and Sussex; in Germany the Spree and other river valleys; in Victoria, Australia, the damp *sour grass* pastures; in America the bottom lands in the Southern

States, in Nicollet Co., Miss., Conecuh Co., Ala., Polk Co., Tenn., Madison Co., Va., Kent and Cuyahoga Co., O.; in Asia on the damp rich soils of Siberia, Afganistan, Thibet, etc., and in Northern Europe those of Finland are spheres of distomatosis.

It is worthy of notice that the affected sheep, when removed to high, dry pastures, or to salt marshes, fail to transmit the parasite to healthy sheep. The disease may prove fatal to them, but healthy sheep which mingle with them escape. This is due to the absence of the fresh water snails, the necessary hosts of the encysted brood capsules and the rediæ.

A flock which is folded at night and kept off the pasture until the morning dew has evaporated will sometimes escape. The same is true as regards lung worms. The embryo worms and the unencysted cercaria alike retreat from the dry vegetation. Light showers may, however, act like the night dews and endanger the sheep.

Again in very wet seasons, certain habitually "*rotting lands*" may prove comparatively harmless, while the sheep on higher and comparatively less suspected pastures suffer. The infested snails dislike to be completely submerged, and migrate to the adjacent higher level which is still damp but not submerged. The sheep too eat off the tops of the grasses which project above the water, and fail to take in the lower parts, on which the cercaria may be more numerous.

Harms and Michalik claim that they have seen the disease transmitted by hay, the encysted cercaria retaining its vitality though dried.

Frost must be looked upon as a bar to the infesting of animals. The snails disappear or perish under frost, and it is only when a thaw comes that these and the cercaria can resume their activity so as to invade the system of the mammal. Animals may come down with the disease during a long freeze, but it is from distomata taken in before it set in, or from those that are preserved in dry fodder. Continental countries with long winters have a relatively protracted immunity, while warm climates, and insular countries like Great Britian, with open winters, may have stock infested at almost any season.

As the cercaria may escape from the snail at any season when the temperature is above freezing, and as the period from the egg

to the young fluke need be little more than 40 days, the contention of Gerlach and Johanni that sheep are never infested in spring cannot be successfully maintained. With the advance of the season, however, and the extensive encrease of the larvæ in the snails the cercaria become more and more abundant, and thus late summer, autumn and early winter are preëminently the seasons of distomatous invasion.

Receptivity to distoma and distomatosis on the part of the mammal is mainly associated with low condition. *Lambs* suffer more severely than the mature sheep, and *old ewes* with worn out teeth and weakened systems rather than the vigorous middle aged. *Debility* from winter confinement and insufficient or unsuitable food, and the disposition to devour the first growth of spring in the low, damp and infested localities contribute to the severity of the attack. Debility from other parasitism or any pre-existing disease is equally predisposing. So it is with the lowered vitality resulting from damp beds, dark, close buildings, and faulty fodder, such as an exclusive diet of roots, spoiled marc, or ensilage, rank aqueous grasses, musty or sunburnt hay, or that which has been injured by wet weather.

Symptoms in Sheep. It was noticed by Bakewell and others that when sheep were first infested, there would seem to be an improvement in condition, lasting from one to two months, so that shrewd flock-masters, who had sheep nearly ready for the butcher would hasten the finishing off, by turning them into a *rotting* pasture. The result is explained by the stimulating of the liver function by the presence in the gall ducts of a limited number of young flukes, by the encreased formation of glycogen and sugar, by the more abundant metabolism of albuminoids, and above all by the more liberal supply of bile and the consequent improvement in digestion, absorption and assimilation. Not only do the sheep encrease in bulk and weight but the mutton is said to be specially tender and juicy. But this improvement may be entirely obviated by the great numbers of flukes ingested and at best it is very transient and fallacious. Even before the sheep begins to lose weight, the apparently fatty deposits are found to be of a very liquid and watery consistency, and when the balance has once been turned, wasting goes on with a rapidity unequaled in almost any other condition. Usually before three months after

the ingestion of the cercaria the sheep is already far on the road to anæmia and dropsy.

The early stage marked by improvement or even maintenance of condition, may last from four to thirteen weeks, and may be complicated with interdependent disorders, like the cerebral apoplexies noted by Gerlach.

This is followed by a variable period of encreasing anæmia, dropsy and emaciation which has secured for the affection the term *cachexia*. This usually begins in autumn or early winter.

The tendency to a dropsical effusion is early seen in the pallor and puffy appearance of the skin and mucous membranes. Shepherds and flockmasters judge largely by the appearance of the eye, which they examine by everting the upper lid over the tip of the index finger. The mucosa on the lid, the protruding haw and the sclerotic present a puffy infiltrated appearance, and instead of the bright, pink, branching lines of the blood vessels, these appear of a pale, yellowish hue, or are altogether imperceptible. The blood may sometimes appear dark in contrast with the pallor of the mucosa. The skin soon becomes pale and bloodless, devoid of its normal ruddy hue and unctuous secretion, and harsh, dry and scally on the hairless parts, under the belly or inside the arms or thighs. The wool is dry and lustreless and easily pulled out. The muscles waste and shrink, the spines stand out as a prominent ridge, (razor-back), and the hip bones are prominent and angular. The subcutaneous fat disappears so that when pinched up the skin feels like two thin membranes (paper skin). Manipulation of the loins may cause crepitation from gas bubbles The flank falls in beneath the loins, and the abdomen becomes baggy, pendulous and fluctuating from dropsical effusion. This will change its position, always keeping the most dependent part when the patient is made to assume different positions (ventral, dorsal, sitting, or suspended by the hind limbs). With the ascites there comes marked drooping of the back and loins (hollow-backed). Similar dropsical effusions follow in the chest, and under the skin beneath the chest and abdomen and between the branches of the lower jaw (poke, chockered). This last is fullest after grazing and lessens under a night's rest in the fold with the head elevated.

With the muscular wasting, weakness and debility become ex-

treme, the affected sheep drag behind the flock, are easily caught and scarcely struggle when seized. The head becomes pendent, the expression of the face haggard, dejected and hopeless, and the respiration quick and labored on exertion. Abortions are frequent, and the milk is thin, watery and unfit to support a lamb. The liquor amnii is thin, watery, white and often interspersed with air bubbles. The temperature is variable. Appetite is irregular and capricious, ardent thirst is common and diarrhœa may alternate with constipation. This may depend on sympathetic irritation of the bowels, or on alternate blocking, and discharge from, the biliary ducts.

The most conclusive symptom is the discovery of the myriads of fluke ova in the fæces. A magnifying power of 70 to 80 diameters will reveal them.

Duration. The course of the disease will vary according to whether the conditions of life are good or bad, or as the parasites are few or many. When the weather is cold or variable, the pasture poor and watery, and the cercaria abundant, the symptoms may appear in from four to six weeks after invasion by the distoma, and death may follow in a few weeks more, while under the opposite conditions of few flukes, rich, dry, wholesome pasturage, supplemented by grain, the flukes may remain for six months in the liver before they give rise to symptoms of illness (Simonds) and the attack may result in recovery.

Complications of various kinds may hasten death. Thus Gerlach saw cerebral apoplexy occur in the early stages. Bovicini has seen acute hepatitis kill in seven days, and verminous affections of the lungs, intestines or brain, scabies and other disorders are liable to take occasion to attack the weak and debilitated system.

A spontaneous recovery is likely to occur in early summer owing to the passing away of the flukes that have wintered in the gall ducts, but convalescence is usually but partial and the sheep do not thrive as before. A fatal result is usually heralded by the encrease of the dropsy, the weak indistinct pulse, the utter refusal of food and the recumbent semi-comatose condition in which the animal passes most of its time.

Lesions. Morbid Anatomy. In the early stage when the young flukes are migrating into the liver, there is more or less

enlargement and congestion of that organ, with small centres of blood extravasation into its substance, and surface perforations, as large as pinheads from which a bloody serosity oozes on pressure. The bile and peritoneal fluid are tinged with red and may contain embryo flukes Later the liver is decidedly enlarged, more particularly the left lobe, and covered with fibrous exudates, which may bind it to adjacent organs and in which young flukes $\frac{1}{8}$ inch in length may be found. The same may be found in the gall ducts and gall bladder. The parenchyma is softened, granular and fatty, and yet the interstitial connective tissue may be thickened. This thickening is especially noticeable around the gall ducts, the walls of which are congested, ecchymosed, and denuded of their epithelium by a catarrhal inflammation. Emaciation is already shown in the absence of sub-cutaneous and interstitial fat, and the soft aqueous character of the adipose material, in the atrophy, pallor and flaccidity of the muscles, in the presence of dropsical exudates into the connective tissue and serous cavities, and in the absence of any firm rigor mortis.

In the more advanced stage, seen in sheep that have died after a lingering illness, the anæmia is extreme ; the blood is pale, thin and watery ; the subcutaneous and intermuscular fat has disappeared or is represented largely by a watery liquid ; the muscles are everywhere pale, colorless, flabby and shrunken so that the bones project strongly ; there is no cadaveric rigidity ; the connective tissue generally is dropsical, but especially that of the dependent parts (under the jaws, sternum or abdomen). The liver is shrunken, firm, fibroid (even grating under the knife), with rounded edges. It shows light-colored and hæmorrhagic spots ; and on its posterior surface, branching from the porta, the dilated gall ducts with enormously thickened walls and biliary encrustations. These ducts stand out like thick, yellowish white cords. When cut into they are found to be encrusted and distended by casts of biliary salts and coloring matter, and enclose a thick, dark, grumous bile, containing flukes, (50 to 1000) and myriads of their ova. The contents may be at points a stiff dark-brown mass, like fine wet sand, made up almost exclusively of the ova (Thomas). In other cases the mottled disorganized liver and the distended and encrusted ducts, may show no flukes nor ova, the parasites having reached the limit of their life in the mam-

malian host and passed out, leaving only the lesions resulting from their invasion. In still other instances, the apparently fluke-free bile has a light color and consistency, but is in constant motion from the movements of myriads of young flukes. This may be made visible under a pocket lens, or if lifted on the point of the scalpel, each is seen to form a small, transparent jelly-like mass.

The bile in the gall bladder is also thick, deep green or violet, and mixed with mature or young flukes or ova.

Wandering flukes may be found outside the biliary passages. Thus they have been seen in the substance of the lung or liver, or in a thrombus in the portal vein or in one of its hepatic branches. In some instances the victims die early of accidental complications, such as pulmonary congestion, to which a sudden frost, a cold or wet storm, and the thin watery condition of the blood specially predisposed them. In such cases the consolidated dark-red or black lung which sinks in water, and the presence of flukes in the gall ducts are characteristic, even if the case is too recent to show anæmia, emaciation, jaundice and blanching of the tissues. Other complications are intestinal or lung worms, scabies, and asthenia, which are favored by local conditions or debility. A distinct feature in many advanced cases is a heavy mawkish odor of the carcase, which becomes still more repulsive with the unusually speedy advent of putrefaction. Simonds records a case of choleraic diarrhœa in man, proving fatal in two days and apparently hastened or aggravated by this offensive odor. This debility, like the fatal conditions which persist after elimination of the liver fluke from the gall ducts, implies a general bacteridian infection (septicæmia hæmorrhagica, pasteurellosis, lombrix, etc.), superinduced by entrance of the bacteria through wounds of the mucosa and other tissues caused by the flukes. In this baneful work, other coexisting parasites usually share.

Prevention. The difficulty of reaching the liver flukes by effective parasiticides emphasizes the importance of preventive measures. These must be conducted along two lines: First, the destruction of the flukes, and second, the invigorating of the system so that it bear up against the invasion and survive it.

Destruction of Flukes. **Thorough drainage** of pastures is the most effective measure as the ciliated embryo and cercaria

are both aquatic, living in fresh water puddles, ponds, pools, streams or lakes and in their absence the life of the fluke is cut off, and its development into the mature parasite of the mammal prevented. In the same way the mollusc (limnœa truncatula) which forms the host of the rediæ, or brood capsules, requires a damp soil, or a watery home, and in the absence of these on dry soils the ciliated embryo necessarily perishes. This is the most rational, thorough and effective preventive measure.

If drainage is impossible the land may be pastured by cattle or horses, in which distomatosis is rarely fatal, but as such animals will carry the parasite they should never be allowed to enter on any non-infested damp land to which sheep have access. Though they may not themselves perish from distomatosis they can dangerously stock other pastures. Hares and rabbits should be exterminated or excluded from pastures by nets.

Stiles quotes Ashmead to the effect that in Hawaii the disease has been kept greatly in check by cultivating **frogs** and **toads** in the infested waters and pastures to devour the snails and thus cut off the trematode in its encysted career. Further that Hutchinson observed that the introduction of **carp** into the Columbia River, and its tributaries had the same effect. The carp were introduced in 1893 and have multiplied abundantly in the lower, still waters of the Columbia, Williamette, etc., and in sloughs and stagnant pools, while they have penetrated little into the higher and more rapidly flowing tributaries. The farmers and others drew attention to the facts that where the disease formerly scourged the flocks along these rivers it has become comparatively mild, while elsewhere it prevails with all its former fury. Sheep from the western slope of the Cascades exclusive of the Columbia River bottom suffer to the extent of 75 per cent., while on these formerly destructive bottoms but 5 per cent. are infested. The voracious carp eat everything, vegetable and animal, that comes in their way, and while greatly maligned for devouring other fish, they may fairly be claimed as a friend of the farmer in preserving his valuable flocks. The principle is a most valuable one in securing the destruction of dangerous parasites and their invertebrate bearers in the undeveloped larval stage of the former, and we may expect ere long a general culture of frogs and toads in malarial districts to devour the larvæ ("wrigglers") of anopheles in breeding swamps and pools.

Culture of the affected pastures would also accomplish much, as the distomata would perish for lack of the mammalian host. Yet as they can reach maturity in nearly all herbivora and omnivora it would be essential to exclude game and vermin such as deer, antelope, rabbits and hares, in order to good results.

Avoid drainage water from infested pastures. As in the case of other parasites, extension may follow the water-shed, and hence streams which drain infested land, lakes or ponds, may carry the embryo, the mollusc host, or the cercaria, and are to be carefully avoided.

Salt marshes and **salt licks** are destructive to the fluke, but especially to the embryo and cercaria, as well as to the mollusc host and therefore infested sheep or other animals can always be safely turned on such pastures. Perroncito found that a 2 per-cent. solution killed the rediæ or encysted cercaria in 5 minutes, and a .64 per cent. solution in less than an hour.

Sowing salt on infested pastures has been recommended, 400 lbs. being applied per arce. This would be especially applicable to such low lying swamps as cannot be drained.

Feeding salt daily to each sheep is another resort. Mix 3 lbs. salt with 200 lbs. ground oats and give to each sheep ½ lb. of the mixture daily. The salt further stimulates digestion and assimilation. In Egypt saltwort (salsola kali) pastures are alike preventive and curative.

Salt the drinking water. When the drinking water is infested it should be fenced in and water supplied daily in troughs with 1 part of salt added to every 200 parts of water. (1½ ozs. to 2 gallons).

Quick lime has been found to destroy the distomata and their molluscous hosts. This has accordingly been used as a top dressing on the pastures to the extent of 400 lbs. to the acre. It is, however very soon transformed into calcium carbonate in which condition it is no longer effective.

Lime has also been advised to mix with the manure, but it hastens decomposition and greatly impairs its manurial value.

The manure of animals, that have been on infested pastures or that were watered from infested streams or pools, should never be spread on wet soils (except salt marshes or licks). It may be used on dry land. The droppings on infested pastures should

be turned over with a shovel to dry, and sprinkled with finely powdered salt, or, better, copperas.

Overstocking of infested pastures is to be avoided, as the more closely it is grazed the greater the probability of taking in the encysted cercaria on the lower parts of the stems and leaves. There is also the danger of tearing up the plants by the roots, and on the part of the sheep a greater susceptibility from the poverty of the feeding.

If infested sheep are fit for mutton they should be killed, as otherwise they continue the distribution of the ova for months. Sheep that have died or been killed with distomatosis, should be heavily salted and deeply buried in dry soil or boiled to ensure the destruction of the ova. Above all the liver and offal should not be given raw to dogs, cats or other animals which would carry and distribute such ova in their fæces.

The most important of all precautions is to avoid turning infested sheep on fresh, non-infested pastures. In purchasing sheep therefore, flocks that have been on low, damp infested lands must be refused, and in public markets, all such sheep as show the characteristic anæmia and asthenia, and particularly those with slight icterus and a pallid, cloudy, thickened, puffy or dropsical condition of the conjunctiva. By everting the upper lid over the finger and closely scrutinizing it, this condition can usually be made out.

In a country in which liver distomatosis is known to exist, it is well to place all new purchases of sheep or cattle on a dry sandy soil until time has been allowed for the exit of the ova of any flukes which they may harbor. The longest limit of the life of the mature fluke in the liver should dictate the duration of this period of quarantine. Leuckart allows that mature flukes begin to leave the liver after three weeks; many however, survive for six months, and Gerlach sets the limit at from nine to twelve months, while Thomas claims to have seen the parasites in two sheep fifteen months after infesting. A period of seclusion of one year would meet the requirements in almost every case.

Soiling might be adopted as a prophylactic measure, as it would prevent the diffusion on the pastures of the droppings of the sheep and their myriads of ova, and in the absence of the

embryos the molluscs would escape infesting, so that the parasite would not be found in the cercaria or encysted form in the following season. The manure of the sheep could be safely used on dry cultivated lands. If spread on pasture it should be first thoroughly salted, or treated with copperas or sublimate.

Zundel advised *two sheep pastures*, for the first and second halves of the year respectively, to limit the numbers of the flukes, but this would have only a partially beneficial effect.

Invigorating the Sheep. *Shelter* from severe storms and damp beds is important. A *rich, dry, grain feeding* is no less so. The distoma is a blood sucker and the disease is one of anæmia and debility. A rich diet is a desideratum. We should second the natural inclination of the sheep in giving dry, upland pastures with dry, sweet, aromatic grasses. Better still to give farinaceous grain or leguminous seeds—oats, maize, barley, rye, beans, peas, lentils. Linseed cake, rape cake or cottonseed meal may be substituted. A well balanced ration may be secured by combining the grains with the more nitrogenous seeds. A daily ration of ½ lb. will usually suffice. These are often given with iron, aromatics and bitters, as in the following :

Linseed, rape, pea, oat, barley or corn meal, or unbolted wheat flour	40 lbs.
Powdered gentian or anise seed	4 lbs.
Common salt	4 lbs.
Sulphate or oxide of iron	1 lb.

This mixture may be given to the amount of ½ pint daily.

Veith advises the addition of oak bark, calamus root, and juniper berries, and Trasbot advises that of dried leaves of oak, elm, hornbeam, and other astringents, together with their young shoots and buds.

Curative Treatment. No remedy can be absolutely relied upon to kill the flukes in the gall ducts. The dilution consequent on absorption into the blood of the portal vein serves to render most vermifuges ineffective.

Tonics. The various bitter tonics, aromatics and astringents act in the main by sustaining the constitutional vigor and enabling the patient to outlive the attack in case of a mild infesting. Among the agents thus used have been gentian, wormwood, absinthum, wild chicory, oak bark, willow bark, fir or pine leaves, chestnut, germander, acorns, quassia, madder, juniper berries,

pepper, anise, burnet, etc. Compounds of iron, common salt and other tonics are used as advised under prevention. *Vermifuges.* Volatile and diffusible agents like kerosene, crude petroleum, asafœtida, garlic, creosote and heavy empyreumatic oils have been lauded. Benzine (2 drs.), naphthalin (10 to 15 grs.), naphthol (8 to 10 grs.), oil of turpentine (1 dr.) daily are among the best, and any one may be given twice a day for a week. Picrate of potash, liver of antimony, and tincture of iodine have each been tried with little effect. Arsenious acid (½ gr.) daily for some weeks tends to destroy the flukes and tone up the system and has been successful in mild cases. Perroncito used male fern extract, successfully with the drawback that it caused anæsthesia and tympany.

The greatest care must be taken to protect the patient against taking in more of the parasites, all of the preventive measures prescribed being adopted. Then in the moderate cases a liberal feeding on grain or farina with iron, aromatic and bitter tonics, will often enable the patient to survive, and the liberal daily use of common salt (2 drs.) and one or other of the diffusible vermifuges above named, or of arsenic will serve to reduce the numbers of the flukes, and bring about a favorable result. The average uncertainty of this result, however, and the enforced and prolonged seclusion of the patient to prevent contamination of fresh pastures, constitute serious drawbacks to treatment.

Post-Mortem Inspection. Slightly infested livers may be marketed to be well cooked; badly infested cirrhotic livers, and those with migrating flukes in the hepatic tissue should be tanked. Mature, raw flukes may live in man, the ova must pass through the intermediate stages in molluscs etc., before they can infest man. But like dogs, men may pass the ova through the intestines to infest molluscs and pastures.

DISTOMA SPATULATUM. D. JAPONICUM. D. SINENSE.

This like the *Paragonimus* is a native of Japan, and infests both man and cat. The worm is colorless, or slightly pink, translucent, and marked off into a cephalic and a caudal part by an indentation at each side, with the ventral sucker at the line of union. The dark colored uterus and the white testis, vas deferens, ovary, etc. shine through the transparent skin. The skin

is glabrous, the venter more convex than the dorsum, and the caudal end forms a rounded angle. The worm is 11 to 12 mm. long, by 2 to 3 mm. broad. The ova are unusually small, ovoid, and transparent.

The mature fluke infests the gall ducts and bladder of man and cat, a single cat having furnished 600 specimens. The transformations of the parasite and the intermediate host of the larval form are unknown.

The *symptoms* are disturbed digestion, morbid appetite, enlargement of the liver, with rounding of its edges, vomiting, enlarged spleen, emaciation, diarrhœa, ascites and marasmus. The discovery of the ova in the fæces is conclusive. Much, however, depends on the number of flukes present, under a slight infestment men have continued to follow their usual avocations with comfort for a period of six years.

Prevention will follow the lines laid down for *Distoma Hepaticum*, with special application to the victims. Cats must be withheld from drinking ditch or other surface water, and their numbers must be restricted. Men must avoid all surface water unboiled, and all uncooked vegetables. Human and feline bowel dejections should be treated with salt or other vermicide and kept from land which is employed for raising fresh vegetables.

DISTOMA TRUNCATUM. D. CONUS. D. CONJUNCTUM. D. FELINEUM. D. CAMPANULATUM.

This small truncated fluke, 7 mm. by 2 mm., is found in the bile ducts of dog, fox, cat and seal in Europe, Asia and America. The ventral sucker is in the anterior third of the body with the genital pore immediately in front. The simple unbranched cæca, right and left, extend into the posterior third of the body, while the folded oviducts are confined mainly to the middle third. The body is reddish when fresh, spinous in youth, it may be glabrous in older. The lobed testicles are lodged one behind the other and immediately posterior to the lobular ovary.

In cases of recent infestment the bites of the flukes lead to irritation of the mucosa, desquamation of its epithelium, and the growth of a mass of connective tissue fibres which envelope the fluke as in a fibroid case, or nodule. Later this connective tissue hypertrophy extends around and within the acini, and

under the pressure of this new formed tissue the cells, or parenchyma, are destroyed and a condition of inter and intra lobular cirrhosis established; among the resulting secondary disorders ascites, debility and emaciation are prominent. The ova may be found in the fæces or urine on sedimentation and microscopic examination.

Prevention. The most effective treatment must be prophylactic along the lines laid down under *Distoma Hepaticum.*

Distoma Pelineum, once held to be identical with *D. Hepaticum* is now held to be distinct. Its prevention and treatment must be similar to that adopted for the hepaticum.

OTHER PARASITES OF THE GALL DUCTS.

Among other parasites which enter the gall ducts from the duodenum may be named for the different genera of domestic animals as follows:

Horse: **Sclerostoma Equinum.**
Cattle: **Amphistoma Explanatum. Ascaris Bovis.**
Pig: **Œsophagostoma Dentatum. Ascaris Suis.**
Cat: **Ollulanus Tricuspis.**

ADDITIONAL PARASITES IN THE LIVER.

Dog: **Filaria Hepatica. Eustrongylus Gigas. Cysticercus Cellulosæ.**
Pig: **Cysticercus Cellulosæ.**

None of these are in this habitat very dangerous to the host unless they block the gall ducts, or induce infective inflammation in their coats.

PARASITES OF THE PANCREAS.

Same intestinal round worms invade pancreatic and biliary ducts. Cysticercus cellulosa in dog and pig. Cause obstruction, inflammatory and infectious disorders. Treatment.

These are either encysted parasites, or the parasitic denizens of the duodenum which have made their way into the pancreatic duct.

The cysticercus cellulosa has been found in the pancreas of the dog, and may be present in the pig as well.

The sexually immature **Sclerostoma Equinum** (strongylus armatus) has also been found encysted in the gland, and being a parasite of the colon had doubtless made its way by penetrating through the walls of that viscus.

The **ascaris megalocephalus** has been found in the pancreatic duct, having penetrated from its normal habitat in the duodenum. The invaded duct was dilated and considerably thickened (Generali).

The **ascaris suilla** has invaded the pancreatic duct of the pig, from its normal home in the duodenum. (Railliet and Morot).

According to their numbers, these may create more or less change of structure and function of the gland, and they may introduce microbes, to cause catarrhal, calculous and other infections. Their presence, however, has never been recognized by definite symptoms during life, and treatment has never been possible.

The *pancreatic fluke* is an important parasite ot cattle in S. E. Asia.

THE PANCREATIC FLUKE. DISTOMA PANCREATICUM. DICROCŒLIUM PANCREATICUM.

This has the same general character as the lancet-fluke, but is larger and relatively considerably broader. The non-ramifying cæca extend into the posterior part of the body, the oral sucker is terminal, the ventral sucker at the junction of the anterior and middle thirds, with the two testicles on the two sides and slightly behind, while the branching uterus extends to the caudal end. The genital pore is situated midway between the two suckers in the anterior third.

Habitat and Geographical Distribution. This fluke lives in the *pancreatic duct of cattle and buffaloes* in Japan, Tonkin, and Cochin China, in the latter country as many as 50 per cent. of the animals suffering were fat, and 90 per cent. were in poor condition. It is found at all seasons of the year and in the dry as well as the wet season. This is in keeping with the tropical or semi-tropical latitude and the opportunity for the evolution of the parasite, outside of the mammalian host, at all times.

Lesions and Symptoms. In badly infested animals the canal of Wirsung and its branches become greatly distended, so that they

have been compared to stuffed sausages, but without such marked thickening of the walls as attends a severe infestment of the gall ducts by the liver fluke. In severe infestments however the interference with the important pancreatic secretion and digestion cannot fail to be very injurious, and this agrees with the fact that it is the emaciated animals that harbor the largest number of the flukes. Sedimentation and microscopic examination of the fæces will detect the presence of the operculated ova.

Treatment is nearly useless, but *prevention* along the lines laid down for the Distoma hepaticum would be especially appropriate.

PARASITES OF THE SPLEEN.

Parasites wander into the spleen, as into the liver, from the intestines, through the portal blood; others bore through the tissues. *Linguatula denticulata*, in man and dog. *Cysticercus cellulosa*, in man and pig. *Cysticercus tenuicollis*, on peritoneal surface. *Echinococcus*, in substance, in man, herbivora and omnivora. *Distoma hepaticum*, in cow. *Œsophagostoma Columbiana:* Usually calcified, in sheep. *Actinomycosis*, extending to or from other viscera. *Symptoms* not pathognomonic; intelligent treatment impossible. Prevention depends on the adoption of intelligent measures against parasites generally.

The spleen harbors the same parasites as the liver and peritoneum though they are by no means so common, probably because the organ is less directly in the track of the portal circulation.

Linguatula denticulata has been found in cysts of the spleen of man and dog, the walls of the older cysts being often cretaceous. (See **Linguatula tænioides**).

Cysticercus cellulosa occurs in man and pig though not frequently.

Cysticercus tenuicollis is found attached to the splenic peritoneum in herbivora.

Echinococcus is the most common cystic worm of the spleen in man, herbivora and omnivora. Thomas records 88 cases in man, of which the spleen alone was affected in 45. Sommer found the spleen affected in 37 out of 1681 cases of echinococcus, and Stengel in 5 out of 79 cases occuring in North America. Ostertag found in a cows's spleen an old multilocular echino-

coccus, partly calcified, and with a very dense, thick, fibrous envelope. Dieckerhoff met, in a horse's spleen, with an acephalocyst about two inches in diameter.

Distoma hepaticum was found by Lucet, alive in a cyst of the spleen of a cow, and Carnet had a similar experience.

Œsophagostoma columbiana or its greenish, calcified cyst is occasionally found under the splenic peritoneum in sheep.

Actinomycosis of the spleen is not unknown and may attain to a large size, binding the organ to neighboring viscera, as in the case reported by Reinemann.

The parasitic affections of the spleen are rarely to be recognized during life so that it is superfluous to refer to treatment. The most reasonable course is to adopt measures for the extermination of injurious parasites from the locality and to protect the animal system against invasion.

PARAGONIMUS WESTERMANNII; LUNG FLUKE OF MAN, DOG, CAT AND PIG.

Synonyms: Distoma Westermannii; D. Pulmonale; D. Ringeri; Mesogonimus; Clinostoma, etc.

Geographical Distribution. Enzoötic hæmoptysis by which this disease is manifested in man has long been recognized in **China, Japan, Formosa** and **Corea**, affecting, it was alleged, from 15 to 20 per cent. of the population in certain areas. Later the cause of such hæmoptysis has been definitely traced to the fluke in the lungs by Manson (1880), Baelz (1880), Taylor (1883), Mura (1889), and Yamagiwa (1890). In Europe and America it has been found especially in animals, many of which have either come from eastern countries or have been presumably connected with such as did come. Thus it was found in the lungs of a tiger which died at **Amsterdam** (Kerbert, 1878); in the lungs of a Japanese dog, (Railliet, 1889); in a cat in the **United States** (Ward, 1894); in a dog in **Ohio** (Killicott, 1894); and in hogs at **Cincinnati** (Payne, Stiles and Hassall, 1893). From the frequency of hæmoptysis in the **Philippines** (Rev. J. Close), where Chinese and Japanese are numerous, there is reason to suspect its prevalence there if not generally in the East. The propagation of the parasite to and in the United States through the arrival of Japanese, Chinese, and soldiers and sailors returning from the

Philippines is a foregone conclusion. A future encrease of the area recognized as infested, and an actual extension of infestment are inevitable.

Specific Characters of Paragonimus. As no definite distinction has yet been shown in the parasite as obtained from man, dog, cat, tiger and hog, respectively, a common description may serve for all.

The parasite is 8 to 16 mm. (Killicott, 16 to 20 mm.) long, 4 to 8 mm. broad, 2 to 5 mm. thick, plump, pinkish or reddish brown (alive), or slaty (preserved); oval or elongate pyriform; anterior end round, blunt, with terminal or sub-terminal oral sucker; posterior end less blunt; ventral sucker slightly anterior to the middle of the body; genital pore close to the caudal margin of this sucker; skin covered with broad scale-like spines; pharynx long; œsophagus very short; intestinal bifurcation in front of the ventral sucker; intestinal cæca, right and left run zig-zag to the posterior extremity. *Male:* Cirrus and cirrus pouch absent; testicles tubular, ramified, one slightly posterior to the other, on each side of median line, excretory duct straight. *Female:* ovary ramified, lateral, right or left; slightly posterior to ventral disc, uterus short, massed on opposite side from ovary. Eggs oval, 80 to 100μ by 56μ. Ciliated embryo develops after eggs are laid. Sporocyst, redia, cercaria, and intermediate host unknown.

Development. Washed free from sputum and kept in water at 80° to 94° F. the ovum in 40 to 60 days develops an embryo, ciliated in its posterior two-thirds only (Manson). The further changes have not been demonstrated, but analogy with the distoma would indicate an intermediate host, probably a mollusc, as necessary to the development of the cercaria which can again infest the mammalian lung. (See Distoma Hepaticum).

Animals Infested. In Japan this parasite is extremely common in *man* and *dog*; it has also been found in Europe in the *tiger*, and in America in *cat*, *dog*, and *pig*. There is reason to believe that its apparent absence from other animals may be largely due to the infrequency of exposure and to the lack of thorough investigation.

LUNG FLUKES IN CAT AND TIGER.

The parasite was found by Kerbert in the lungs of two tigers which died in 1878 and 1881 respectively, in the Zoölogical

gardens of Amsterdam and Hamburg. The Asiatic origin of the tigers suggests that they were probably infested in the east. He found the parasites "always two together, on the outer surface of the lungs, in rather thick, hornlike capsules, which immediately attract attention by their rather blue color." In 1891 Weber found a third case in the royal tiger of Sumatra. The lungs contained 33 cysts containing 2 parasites each; one contained 3 parasites and one a single fluke.

Kerbert describes the paragonimus as devoid of spines on the caudal as well as the cephalic end, but Leuckart and Nakahama, after examination of his specimens, pronounced them identical with those of man.

The Paragonimus was found in 1894 in the lungs of a domestic cat, at Ann Arbor, Mich., by Ward. In Friedberger and Fröhner it is noted that cats suffer in Japan. It showed no clearly distintive features from the parasite of man. The source of the infestment in the Mich. cat is not shown, but it is altogether probable that it took in the fluke in America. There is the further probability that the parasite had been imported in an infested Japanese student, or Chinaman, or possibly in an American returned from the east.

LUNG FLUKES IN THE DOG.

Dogs appear to suffer to some extent in Japan, as already quoted from Friedburger and Fröhner. Railliet in 1890 found in the Japanese veterinary exhibit in the Paris Exposition, specimens of these flukes taken from the bronchi of a dog. Killicott found, in 1894 in a dog dissected at Columbus, O., a large number of these flukes. The entire surface of the pleura was marked by small brown spots, and on the lobes of the lungs, but especially near the roots, and along the dorsal borders, were rounded tumors of a deep red color, contrasting strongly with the pink of the lung tissue, and enclosing the parasites, with some purulent debris. Some were embedded deeply in the lung tissue, with or without a distinct fibrous capsule. The worms were from 15 to 20 mm. in length. The lung tissue contained great numbers of elliptical ova, especially in the vicinity of the encysted worms, where they gave their own brown hue to the parenchyma. They were also abundant under the pleura, both pulmonary and parietal, causing

the brown spots that have been already referred to. Ward, who examined Killicott's specimens, pronounced them to be the same as his own specimens from the cat, and as the Japanese Paragonimus. Nothing of the antecedents of the dog is recorded, and occurring, like the Ann Arbor cat, at a centre of learning it might be suspected that it had been infested indirectly, by human victims who had come from the east. The later discovery of the disease in American pigs lessens somewhat the force of this hypothesis.

LUNG FLUKES IN THE PIG.

The first specimens of these were sent to the Bureau of Animal Industry in Sept., 1898, from Cincinnati, by Dr. A. J. Payne. These came from the lungs of a single hog, the source of which could not be traced. In October, Payne found 35 more infested hogs, and in the first weeks of November 1 per cent. of all the hogs killed at the station harbored the worms. He reported 3 or 4 cases during the latter half of November, 4 cases in December, and 1 in January. In all, Dr. Payne reported 52 cases, though at no time after the dates mentioned were many found at one time.

On the other hand, the lungs of hogs are usually tanked, and minute lesions are not looked for, so that the lack of cases cannot be held to positively imply their absence, but rather the infrequency of aggravated and easily recognized cases. Dr. Payne failed to trace the affected hogs to the districts or farms that furnished them, so that the probable original source of the parasite and its relation to the possible implication of man or other animals in the infested localities, remain in obscurity.

The facts, however, bear out these conclusions: 1st, That the Paragonimus, whatever its original source, Asiatic or indigenous, has already gained a considerable foothold in swine in some localities in the United States. 2nd. From the lack of recorded cases of *parasitic hæmoptysis* in America, there is a strong probability that the infected areas supplying the diseased hogs, have not been infested for an indefinite period, but only for a short time, and that the parasites have been presumably brought by people coming from Asia. 3rd. That the Paragonimus has found in certain districts in America the conditions, including the hypothetical intermediate host, requisite to its permanence and

extension. 4th. That sanitary considerations demand the tracing out of infested areas, the suppression of the affection, the seclusions or safe disposal of all infested subjects, and rigorous supervision of all arrivals of men or animals from the infested east.

The *lesions* found in the lungs of hogs closely agreed with those of the tiger ; almost every cyst enclosed two worms—only on rare occasions would a cyst contain one or three. The cysts were from 12 to 36 mm. in diameter, and contained a semi-fluid, chocolate colored matter containing numerous ova. Sometimes two adjacent cysts communicated. The cysts were mostly on or near the surface of the lungs, but a number were deeply imbedded in the lung substance.

The Paragonimus obtained from American hogs averaged somewhat larger than the specimens from dogs or human beings in Japan, but the general characters were essentially the same. There is no good reason for supposing them to be specifically distinct.

Symptoms are lacking, as the worms were only found *post-mortem* in hogs in good enough condition to be killed for pork. The good condition of the hosts is again in perfect keeping with the experience of the human victims in Japan, most of whom, though attacked with hæmoptysis, suffer so little in their general health, that they never think of consulting a physician. Still, in badly infested pigs, as in man, there can hardly fail to be more or less cough, a brownish or even a bloody expectoration, abounding in the trematode ova, and a falling off in condition, as compared with the liberality of the ration.

LUNG FLUKES IN MAN. PARASITIC HÆMOPTYSIS. JACKSONIAN EPILEPSY.

The ravages of the *Paragonimus Westermannii* in man, in Japan, have been long recognized, and have received much more attention than the infestments of the lower animals. Even in man, however, the extent of its prevalence cannot be fairly estimated, as the disease is mild or of tardy progress and the great majority of its victims never consult a physcian. Many cases too are set down as tuberculosis, no examination of the sputum having been made to detect the presence of the ovoid trematode ova (Taylor). Baelz mentions one Japanese village where almost

all the inhabitants harbored the lung-worms and Blanchard says that certain villages in Okayoma and Kumamoto are so badly infested that they are ostracized by neighboring villages and even the physicians dread to go there for fear of infestation.

Conditions favoring infestment seem to be mainly such as would expose the person to the risk of taking in the young fluke in water or green vegetation. The *age* from 11 to 30 furnishes by far the greatest number of cases, the victims being presumably exposed to questionable water apart from the safer well supplies. *Men* suffer much more than women, and in many cases almost exclusively, being not only exposed to the impure country water, but more accustomed to drink it unboiled, while the women, indoors, have theirs boiled and taken in the form of tea. *Out-door* occupations, for a similar reason, strongly favor infestment, more than three-fourths of all patients being *farmers*. This out-door life contributes to a *strong constitution* which has also been adduced as favoring an attack. The Japanese habit of eating molluscs is supposed to be a main cause and people living outdoors are tempted to take these raw.

Symptoms. The symptoms vary with the organ invaded by the parasite.

(a) *Lung Invasion.* This is the common seat of the parasite, and especially near the root of the lungs, the cyst opening into a bronchium. The phenomena begin imperceptibly and encrease gradually, a slight cough leading to a brown or reddish expectoration, resembling that of acute pneumonia, but easily distinguished by the absence of fever, and by the presence in the sputa of myriads of the characteristic elliptical ova of the trematode (sometimes 12,000 daily). Spitting of blood is common or occurs later and can be roused by voluntary coughing. The rusty or bloody expectoration at first proves intermittent, with intervals of suspension, but later with extension of the disease it becomes constant, together with the cough and considerable discomfort. It has been largely mistaken for tuberculosis but microscopic examination of the sputum corrects this error. The expectoration, at first scanty, as well as intermittent, tends later to become profuse and constant, and bleeding more frequent, ten or twelve ounces being often ejected in a few hours. It is always aggravated by violent exertion. Slight cases may continue for

ten or twenty years with comparatively little discomfort, but with a more extensive infestment there is hurried breathing, dyspnœa on slight exertion, anæmia, weakness, prostration, œdema, and more frequent and profuse hæmorrhages. In the early stages auscultation and percussion give little or no morbid indication, but in case of extensive invasion, there are blowing sounds, mucous or gurgling râles, wheezing, and areas of lessened or abolished resonance. Even in advanced cases it is rare to find any marked elevation of temperature.

(b) *Liver Invasion.* The presence of the fluke in the liver has been noted by Yamagiwa, associated with cirrhosis, ascites and other symptoms of the cirrhotic degeneration. Unless betrayed by coincident invasion of the lung, or by the detection of the elliptical termatode ova in the fæces, a correct diagnosis is unlikely.

(c) *Brain Invasion.* One such case is reported from Japan by Otani, associated with infestment of the lungs, and one by Yamagiwa, without record of lung infestment. Both showed more or less local paresis, and Jacksonian epilepsy, clonic spasms in circumscribed groups of muscles, with unconsciousness, advancing to other brain disorders, and finally exhaustion and death.

(d) *Peritoneal Invasion.* With development of the fluke in the peritoneum (omentum, mesentery, etc.) no special symptoms were observed. The lesions were discovered *post-mortem.*

Prevention. In the case of the United States, with small areas only of a large continent invaded by the parasite, every means should be taken to extirpate it, and thus prevent a general diffusion which could only mean a public calamity.

Men or *animals* arriving from infested countries should be detained in quarantine and under a rigid scrutiny to detect any cough with rusty or bloody expectoration containing the elliptical fluke-eggs. *Animals* showing such invasion should be at once sacrificed and their carcases burned or boiled. The *human victim* should be kept under strict sanitary supervision, by preference on a salt marsh, and compelled to expectorate only into a sputum box to be burned. If cuspidors are used indoors, they should be dry and filled with salt which can be roasted or, if need be, deeply buried. Any escape of the sputum into the soil,

or into fresh water, is only an invitation to the extension of the Paragonimus.

Cats, dogs or hogs coughing up a rusty or bloody sputum, should have the latter examined for the fluke eggs, and if found, the host of the parasite and all of the same genera that have lived with it, together with all susceptible animals in the same place, or on the water shed from it, should be secluded and destroyed at public expense, and the carcases safely disposed of as indicated above.

In case of *hogs* being found to be infested when killed, their lungs, and viscera, together with those of all others coming from the same source, should be rendered, or otherwise thoroughly devitalized. While it is perfectly true that the ova found in such specimens cannot directly infest the persons who may eat them, but must (according to all analogy in trematodes), pass through an intermediate invertebrate host to fit them to infest the mammal, yet if infested products are allowed to pass into consumption at all, uncooked scraps are thrown out, the ova develop the embryo, the latter finds its suitable invertebrate host, and the propagation of the parasite and the disease follow. It is half-measures, speciously based on unquestionably scientific facts, but ignoring others no less important, that render sanitary work imperfect and bring upon it discredit and condemnation. If the infested hogs and all their products can be thoroughly sterilized and the pork put upon the market, as canned goods, for example, no possible injury can accrue.

DISTOMA MAGNUM. D. TEXICANUM. FASCIOLA AMERICANA. GIANT FLUKE OF THE OX, DEER (AND SHEEP?).

This fluke was found by Bassi encysted in the lungs of Italian deer, later it has been frequently found in the lungs of American cattle, and to a lesser extent in the liver and duodenum. In external outline it resembles the Distoma Hepaticum for which it was long mistaken. It is now known to be a distinct variety and, as shown by Hassall and Francis, not uncommon in the Western and Southern States, and most commonly found encysted in the bovine lung in the midst of a circumscribed area of pulmonary congestion. It proved very deadly to a flock of sheep in Mich., in winter. (Report, B. A. I., 1906).

The worm is 57 to 68 mm. long, by 24 to 35 mm. broad. As usually met with in cattle it has not been in great numbers, and it has so little interfered with health that the animals were slaughtered in fair or high condition. Bassi, however, obtained 110 parasites from a single deer, and under favorable conditions one can easily realize that it might prove dangerous or destructive.

Dinwiddie found them encysted in the livers of all cattle in St. Francis and Lee Counties of Arkansas, so that the livers were held unmarketable. Francis in Florida found that two year old cattle suffered seriously, while mature steers, though largely infested, survived and did well. Dinwiddie found the omentum "dotted with black spots and streaks," the lymph glands in the porta of the liver "swollen and black", the liver enlarged and bosselated with fluke-bearing cysts, the walls of which were thick, firm and hæmorrhagic and enclosing flukes (usually two), or, if older, attenuated, flukeless and holding only greenish yellow cretaceous contents but no fluke. The fluke when present was folded or rolled longitudinally and surrounded by fluid. In the absence of the fluke, shreds of tissue represent the remnants of the parasite.

In the substance of the lung the fluke is found in a similar hæmorrhagic and inflammatory habitat.

In severe infestments leading to pathological symptoms these agree in the main with those of D. hepaticum.

The evolution of the parasite is believed to resemble closely that of the parasite just named but the molluscous host is not certainly known. *Prevention* would proceed on the same lines as in liver-rot of sheep.

EGYPTIAN LIVER FLUKE. FASCIOLA HEPATICA ÆGYPTIACA.

This was found by Looss in 1896, in the livers of Egyptian cattle and buffalo, and was reported as a new species distinct from Distoma hepaticum. It is not likely to reach America under existing conditions.

NARROW LIVER-FLUKE. SENEGAL FLUKE OF CATTLE (AND MAN?). FASCIOLA HEPATICA ANGUSTA.

This is described by Railliet as taken from cattle in St. Louis, Senegal. Blanchard looks on it as identical with the giant fluke

of the giraffe and with a parasite expectorated by a French naval officer in Brazil.

GIANT LIVER FLUKE OF GIRAFFE FASCIOLA GIGANTEA (COBBOLD). CLADOCOELIUM-GIGANTICUM.

This is described by Cobbold from specimens taken from a menagerie giraffe in England and was claimed by Blanchard to be identical with the Egyptian and Senegal fluke, and therefore capable of infesting cattle, buffalo, and man. Its main interest to us is in the possibility of its importation in menagerie animals and its escape and diffusion in America. A quarantine of giraffes and bovine animals for six months after arrival would protect.

Amphistoma Explanatum is found in the liver and gall ducts of the Indian buffalo, zebu (Railliet) and cattle (von Linstow).

VERMINOUS BRONCHITIS AND PNEUMONIA IN SHEEP. LUNG WORMS. PULMONARY STONGYLOSIS. HOOSE. HUSK. PAPER SKIN. LAMB DISEASE.

Verminous Bronchitis in Sheep. Strongylus Filaria: The longest of the sheep lung-worms; 3 to 10 cm. long, fine, white, head round, non-alated, no buccal papillæ, œsophagus club-shaped; male with bell-shaped caudal membrane, having ten ribs, bilobed, bifid and trifid from before back; ovoviviparous; ova elliptical. Hosts: Bronchia of sheep, goat, dromedary, camel, roe buck, fallow-deer, argali, gazelle. Development: Ovum laid in bronchia, hatches out embryo, which escapes; may live in moist earth or water for months, in two weeks moults, re-enters the sheep in water or food, or dried up as dust, for new internal habitat. *S. Rufescens:* Shorter, 2½ to 3½ cm. long; skin transparent showing viscera brownish red, head not alated, three labial papillæ, caudal bursa has seven ribs; oviparous; ova elliptical; yolk segmented after laying; embryo has pointed tail. Hosts: Bronchia and air-cells, sheep, goat, roe buck. *Development:* As in filaria, yet ovum unsegmented till laid; embryo more viable in water, encysts itself in air-cells, with results like miliary tubercle; when mature, enters bronchia and breeds; alive after three days' drying; infests old sheep more than filaria does, is more destructive. *S. Capillaris:* History of lung strongylosis. *Causes:* Parasite, wet seasons and lands, low, damp undrained pastures, ponds, lakes, rivers, inundations, deltas, low islands, irrigation, watershed from infested ground, dry seasons, debility, overstocking, dews, showers, night pasturage, low health, intestinal worms, pasturing lambs after

sheep, common feeding and drinking troughs. *Lesions:* Bronchitis, profuse purulent exudate, containing worms and ova, blocking, dilatation, collapse, tuberculiform miliary nodules with embryos in air-cells, soft or calcic, lobular pneumonia, complex bacteridian infection. *Symptoms:* enzoötic bronchitis, without patent climatic cause, little hyperthermia, husky cough, wheezing on auscultation, or mucous râle, slow advance, expectoration with worms or ova, diarrhœa, emaciation, anæmia, sunken eyes, flattened wool, shedding, little yolk, thirst, eat earth, young suffer most. *Diagnosis:* Repute of pasture or water, introduction by diseased sheep, whole flock suffers, no cause in weather, etc.; no fever, cough paroxysmal, wheezing, free expectoration with worms. *Prevention:* Keep from infested pastures, especially the damp parts, from irrigated or inundated pastures, ponds, lakes, basins, infested waters, dewy or wet pastures, soil in morning, rotation of crops, new-seeded pastures for lambs, burn, boil, or bury carcases, salt freely, feed generously, give tonics. *Treatment:* Tonic and vermifuge: salt, tar, tansy, absinth, wormwood, copperas, garlic, onions, asafœtida; vermifuge: potash picrate, creosote, oil of turpentine. Fumigations: Sulphur, chlorine, tar, juniper, asafœtida; injections in trachea: salt, iodine, ol. terebinth, carbolic acid, benzine, thymol.

This affection is very prevalent in many localities and causes widespread destruction in flocks, especially in the young, under a year old. It is caused by either or both of two species of worms: the **Strongylus filaria** and the **Strongylus rufescens.** The Strongylus Paradoxus of swine is held by Koch to infest sheep but this must be rare. *S. Capillaris* of the Goat must also be named.

STRONGYLUS FILARIA.

This is the longer of the two common lung worms of sheep: The *Male* is 3 to 5 cm. long, and the female 5 to 10 cm. and of the thickness of a stout cotton thread. It has a white body, with a dark longitudinal line, of uniform thickness and slightly attenuated at each end. Head rounded, perceptibly enlarged; without alæ; mouth terminal, round without noticeable papillæ; œsophagus club-shaped, enlarged posteriorly; with two unicellular glands; anus near caudal extremity. Caudal pouch of *male* bellshaped, with ten ribs, the posterior trifid, the middle bifid, the anterior bilobed. Two brown, thick, short, curved spicula. *Female:* tail conical; vulva three sevenths the distance behind the head, with two salient lips; two ovaries, in front

and behind the orifice. Ovoviviparous; ova elliptical; .01 mm. long. Embryo 540μ long.

Habitat. Bronchia of sheep, goat, dromedary, camel, roebuck, fallow deer, argali and gazelle.

Life History. Development: When the ovum is laid the well-formed embryo is already present and soon escapes. It is not known to undergo further development in the bronchia, but if expelled and thrown into water or moist earth, the egg or embryo may remain alive for months (Colin, Baillet) unless life is cut short by the septic condition of the water (Railliet). Leuckart, who uniformly failed to produce the disease in healthy sheep by feeding the bronchial mucus rich in ova and embryos, found that in the second week of their existence in water or moist earth they moulted and shed the tubercle on the head. He even supposed that they moulted a second time and infested an invertebrate host, but there is no actual proof of this. In any case the moulting appears to be necessary to fit them for a new internal habitat in the sheep's lung. Leuckart found that if kept in water, many died soon after this moulting. Ercolani on the other hand found that if dried up after moulting, they could be preserved for a year and revivified when again subjected to moisture. This is important as explaining the destructive action of these parasites in dry seasons. It renders it possible for the worm to enter the body in dust by inhalation, though undoubtedly it is usually taken in in green vegetation, earth, or water. How it reaches the lungs, whether through the larynx in connection with deglutition and rumination or through the circulation, has not been certainly determined.

STRONGYLUS RUFESCENS. STRONGYLUS OVIS PULMONALIS.

This is the thinner and shorter of the two worms that usually produce verminous bronchitis in sheep. It is sometimes met by itself in this disease but more commonly in company with the strongylus filaria, as the same conditions lead to the preservation and multiplication of both. The *male* is 16 to 28 mm. long; the *female* 25 to 35 mm. Skin very transparent, the cavity of the body appearing as a dark line, and giving the body a general brownish, red color. Head without alæ; mouth surrounded by three labial papillæ. Caudal bursa with 7 rays, the posterior in-

distinct, the middle bifid, and the anterior bilobed. Two symmetrical, flattened, curved spicula, transversely striated. Tail of *female* ends in a blunt point ; vulva at the base of a tubercle close to the anus and just in front of the tip of the tail. Oviparous. Ova elliptical 75 to 120μ long. Yolk is segmented after laying. Embryo with sharp-pointed tail.

STRONGYLUS CAPILLARIS. LUNG WORM OF GOAT, CHAMOIS AND SHEEP.

This is a much smaller worm than the S. Filaria (*male* 14 mm. by 0.04 mm., *female* 20 mm. by 0.065 mm.) Schlegel reports it not only in the lungs of the goat, but also of the chamois and sheep. If once introduced into a locality, it may, under favorable conditions, encrease like other lung worms so as to cause a virtual plague, and must therefore be constantly kept in mind as a possible cause of verminous bronchitis in the smaller ruminants.

Habitat. Bronchia and air follicles of sheep, goat and roe buck.

Life-History. Development. This differs in some respects from that of the strongylus filaria : 1. The embryo worms are not formed until after the egg has been laid by the adult female. 2. They seem to be capable of living a longer time in water or other moist medium outside the body of the sheep (months, Railliet, Neumann). 3. When introduced into the sheep with food, water or dust, the embryo tends to encyst itself in the ultimate air sacs and cells, producing light colored, round masses like miliary tubercles but filled with the worms. 4. When matured in these cysts the worms escape into the bronchia and reproduce their kind. Here too the eggs are laid and, like the embryos and mature worms, may be expectorated in coughing. The embryo lives indefinitely in water, and probably moults. It may be completely dried up for three days and resume its activity when moistened (Railliet). The strongylus filaria is found most abundantly in lambs, and the strongylus rufescens in old sheep, and some observers have inferred that the latter takes years to reach maturity. The difference may, however, be otherwise explained, the rufescens, living in the air sacs and cells, causing greater destructive changes in the lungs and thereby killing off the lambs at an early stage, while the more robust mature sheep, can survive the first attack, and thus go on taking in a new stock of the young worms at intervals.

History of the Disease. The malady was first described by Daubenton in 1768, as being very destructive in Montbard, France. Since then it has been recognized in nearly all parts of the world and in many cases its introduction into a new district can be traced by the importation of infested sheep. It prevails extensively all over Europe, and is most destructive in the southern and midland counties of England and in New South Wales. It is common in New York, and Connecticut, and in many parts of Illinois, and years ago on the unfenced prairies of Iowa it threatened the destruction of the sheep industry.

Conditions Favoring the Disease. The essential cause of the malady is the *parasite*, but that being present, many conditions favor its encrease and diffusion and the receptivity of the sheep on infested pastures.

Wet Seasons. As in the case of worms generally, the abundance of water favors the preservation of the embryo, and its moulting which fits it for a new internal habitat.

Marshes, *pools*, *lakes*, *ponds*, *streams*, *rivers*, *damp bottom lands*, *natural basins*, *inundated lands*, *deltas*, *low islands*, *fens*, *damp springy ground*, and *irrigated pastures* are especially favorable to the preservation of the worm, and hence its frequency in Holland, Belgium, the English fens, and in all low damp lands that have once become infested.

Watershed. The embryo worm is easily carried in streams, hence the access of sheep to water that has drained from infested pastures at a higher level is a fertile source of the malady.

Dry Seasons. While water is essential to the preservation and moulting of the embryo, yet a drouth following such moulting may preserve the larva indefinitely by drying it up, and arresting vital changes without destroying its vitality. Thus an excess of moisture and a drought may successively contribute to the preservation, and diffusion of the strongyle.

Low Condition of the Lamb. Debility contributes to render the lamb more receptive of the worm, and greatly lessens its power to survive its attack, and in this way droughts with insufficient food encrease the mortality.

Overstocking the pastures acts in the same way. The insufficient food causes low condition and weakness, and the necessity of eating close to the ground, endangers the taking of the young

worms that are present on the vegetation near its roots and in the adjacent moist earth. Overstocking further encreases the ova and embryos in the soil.

Dews and Showers cause the young worms to ascend higher on the vegetation and to be taken in in greater numbers if the sheep are left out over night, or turned out in the early morning or in wet weather. In such cases there is always the added danger of the grass coming up by the roots and being swallowed with the verminous soil attached.

Impaired health from previous or coexistant disease must always be recognized as lessening the power of resistance.

Worms in the bowels, liver or elsewhere are especially likely to be present, and to contribute to encrease of mortality.

Pasturing lambs in autumn on meadows occupied by infested sheep in spring or summer, is one of the most common and dangerous practices, as the soil and water are then charged with the young strongyli.

Pasturing of sheep and lambs together on the same ground is equally injurious. *Youth* is one of the most powerfully predisposing conditions. Lambs under a year old show less resistance and perish in far greater numbers than do the mature sheep.

Common feeding or drinking troughs, especially the latter, may become direct causes of infesting fresh animals, as the expectorated embryos naturally fall in such places and, after moulting, may be taken in by other animals.

Lesions of Verminous Bronchitis in Sheep. Either of the three strongyli described or all may be found in the bronchia in an abundant muco-purulent secretion, and often rolled up in bundles, which may block the lumen of the tube. The mucosa of the affected bronchium is congested, reddened, thickened, with its epithelium opaque, softened or even desquamating. The bronchia may show dilations at intervals, filled with the verminous debris. The pulmonary lobulettes or lobule supplied by the obstructed bronchia, is divested of air, collapsed, and carnified (atelectasis) or inflamed. This is especially characteristic of infesting by the strongylus filaria alone. When the strongylus rufescens is present the encysting of the mature worm, with its embryos and eggs in the air sacs, gives the appearance of miliary tuberculosis, which is readily corrected by a microscopic examin-

ation. The tuberculiform nodule may be red and congested at first with a gelatinoid exudate, its periphery may become even more so with the hatching out of the lively embryos, while later it becomes yellow or white in the centre, and finally calcareous. The size varies from a small pin-head to a pea.

In the advanced stages there may be acute, and diffuse, lobular pneumonia, aggravated by an implanted bacteridian infection.

Symptoms of Verminous Bronchitis in Lambs. These are those of bronchitis attacking the majority of the flock at or near the same time, without any climatic or meteorologic cause, advancing slowly in the majority of cases, attended by little hyperthermia, and finally diagnosed by the expectoration of muco-purulent matter containing worms singly or in pellets. The cough may be at first hard, but gradually becomes soft and mucous. It may be at first infrequent, but becomes gradually more common, occurs in paroxysms, is easily roused by driving and is associated with the discharge of a frothy liquid from the nose. By driving the sheep, the breathing is hastened, even at times to dyspnœa, so that the head is depressed, the mouth opened and the subject pants. The cough becomes encreasingly deep, convulsive and painful, and the expectoration more copious, so that the expelled worms can be more easily found. Percussion of the chest sometimes shows tender areas, especially toward the lower part of the lung, also a flatness of sound. Ausculation shows mucous râles, fine and coarse, and sometimes crepitation, but with a general predominance of wheezing or sibilant sounds over given areas. These physical manifestations would suggest tuberculosis, but the rarity of this disease in sheep kept in pasture, and the fact that nearly all the flock are affected, will guard against this error. As the disease is usually complicated by intestinal parasitism, diarrhœa is habitually present, and the soiled hips furnish a further diagnostic feature.

Among the resultant symptoms are loss of appetite, a tendency to leave the herd, emaciation, anæmia, bloodless eye, absence of subcutaneous fat (paper skin), shedding of the wool which is dry and with little yolk, excessive thirst, and depraved appetite, shown in a desire to eat earth.

In the advanced stages the cough becomes very harrassing and death may take place from suffocation.

Diagnosis is based mainly on the known prevalence of the disease on the pasture or water-shed, or the introduction of strange sheep affected with cough, on the slow advent and progress of the malady, on the attack of a large number at a time, especially lambs, irrespective of weather vicissitudes, on the habitual absence of hyperthermia, on the frequency and paroxysmal character of the cough, on the wheezing breathing, and above all on the abundant expectoration of a frothy mucus containing the mature and embryo worms.

Prevention. Two main indications must be pursued: 1st. To prevent the worms from gaining access to the system; and 2nd. To bring the sheep into a condition unfavorable to the survival and destructive work of the worm. Under the first head may be noted:

Keep lambs from pastures previously depastured by infested sheep, especially if these have been *overstocked*, or are naturally *damp*, *springy*, *marshy*, *dense and undrained*, *irrigated*, or if any contain *ponds*, *basins*, *lakes*, or are *watered by streams running through infested lands higher up.*

If watered from a flowing stream *fence out all but the part where they drink* and where there is a decided current.

Better to *water from deep*, *cemented wells receiving no surface drainage nor leaching.*

Lambs should be *kept from infested pastures especially in wet seasons*, *after showers*, *and until after the morning dews have evaporated.*

No less should they be *kept from infested pastures in dry seasons.* Sheep may be safely pastured on lands infested with the lung worms of horses and cattle.

If the nursing ewes are infested they may be *soiled in sheds* or bare yards for four months until the lambs can be weaned, and then the lambs can be turned on a newly seeded pasture apart from all opportunity for taking in the worm. With a liberal supply of milk the lambs do not care to drink water and though they eat from racks and troughs with the ewes they do not find there the young strongylus filaria which has already moulted and prepared for a new lease of life in the lungs. The ewes may be treated or prepared for the butcher. Damp manure, rotten woodwork, etc., which would preserve the ova and embryos must be removed or disinfected.

Infested fields may *be plowed and cropped for years before being laid down to grass.* Or they may be *pastured for two years by horses or cattle* which do not harbor the lung worms of sheep, and the larva of the latter meanwhile perish.

The carcases of all infested sheep should be *burned, boiled* or *deeply buried*, or the lungs should be carefully removed and treated in this way.

Constant access to salt is a means of destroying the young worms as they are taken in.

A *nourishing ration* of farina or cake of linseed, rape or cotton seed, or of oats, barley, maize, or peas is of great value in sustaining the strength of the patient and enabling it to outlive the parasite.

Treatment. First: Stop the entrance of the fresh worms by methods suggested under prevention. *Second:* Sustain the strength of the patient by a generous grain diet. *Third:* Destroy the pulmonary (and intestinal) parasites. *Fourth:* Combat pneumonia and other complications.

A combination of a tonic and vermifuge has been sought in the ferruginous, bitter, aromatic food recommended for distomatosis. Spinola advised sodium chloride 5 parts, and tar, tansy and absinthum, 1 part of each, mixed and given in the food. Zurn recommends: wormwood and sweet fern root, 3 lbs. of each, tansy, bone dust, and copperas 1 lb. of each, mixed and given in a dose of 3 to 4 drachms daily to each lamb. A liberal allowance of garlic or onions will be beneficial and may be added to one of the above mixtures. Asafœtida may be similary used.

As *direct vermifuges* the following have been tried but with no very satisfactory results. Picrate of potash (dose 3 to 4 grains) in oatmeal gruel or mucilage (Neumann) is dangerous because of its destructive action on the blood globules. Creosote 1 oz.; spirits of wine 4 ozs.; water 6 ozs.; dose a teaspoonful daily in mucilage. Creosote 2 ozs.; benzine 10 ozs ; water 2 qts.; dose a tablespoonful daily for a week. Oil of turpentine and tincture of camphor, equal parts; dose a teaspoonful in mucilage or gruel daily. Oil of turpentine 1 oz.; olive oil 2½ ozs. Though these agents exhale from the lungs, their action is not very efficient on the lung worms. They are much more effective on the intestinal parasites.

Fumigations are somewhat better. The affected sheep are

turned into a close room, in which sulphur mixed with a little alcohol is burned in an earthenware plate, set in a vessel having a little water in the bottom. This obviates risk of fire. The fumes are allowed to pervade the whole building, and the administrator stays in the room and breathes the gas, so that he can cover up and extinguish the sulphur whenever the concentration becomes irritating. Violent coughing or sneezing is the signal to stop the burning, and in case of danger to throw open doors and windows. Otherwise the sheep should be left to breathe the fumes for ½ to 1 hour, and this should be repeated daily for a week. The first day's treatment charges the liquid secretion with the gas, kills all the worms within reach and acts as an astringent antiseptic. Every successive fumigation reaches farther, until the ultimate recesses may be reached. After a fortnight a second course of fumigation may be resorted to to kill off the embryos that may have hatched from the eggs left over.

Other fumigating agents have been used such as chlorine gas, formed by mixing common salt, black oxide of manganese and sulphuric acid, but this is much more irritating and dangerous. Others use the fumes from woolen rags, horns, hair, feathers, leather, empyreumatic oils, tar, juniper berries, asafœtida, etc., these being placed on a red-hot shovel, or in an iron pot containing red embers.

Tracheal Injections. These are the most effective measures, and may be thrown in with the aid of a hypodermic syringe between the rings of the trachea. The nozzle, previously dipped in carbolic acid, should be inserted first, if possible in the interval between two rings and then the charged syringe is connected and discharges its contents. The simplest injection is a 1 per cent. solution of common table salt in distilled or boiled water, which may be used freely. Levi found the following very effective: iodine 2 parts, iodide of potassium 10 parts, water 100 parts by weight. Dose ½ drachm, which may be encreased by ½ drachm daily up to 5 drachms. Equal parts of oil of turpentine and some bland oil (olive or poppy seed) may be used in a dose of 2 drachms. Or to the last may be added 1 or 2 per cent. of carbolic acid: dose 2 drachms. Benzine and olive oil, equal parts: dose 2 to 3 drachms daily. Pure benzine (1 dr.) is perhaps best.

Treatment of resultant pneumonia is not promising apart from the destruction of the worms, yet sulphurous acid if not too con-

centrated has a directly soothing and tonic effect on the irritated mucosa. Laxatives and diuretics will often help by eliminating absorbed toxins and the results of pulmonary and bronchial inflammation, and the external application of aqua ammonia, or if the sheep has been shorn, of ammonia soap will be useful.

Measures directed toward the removal of intestinal worms should never be neglected.

VERMINOUS BRONCHITIS IN CALVES. HOOSE. HUSK. LUNG WORMS.

Verminous Bronchitis in Calves. Strongylus Micrurus: 1 to 3 inches long; copulatory caudal membrane of male five-ribbed, tail of female a sharp point; ovoviviparous. Hosts: Calves, bovines. *Strongylus Pulmonaris:* Smaller than micrurus, 7 to 13 lines long, papillæ on mouth, caudal male membrane with seven ribs, female tail pointed. Hosts: Calves, bovines. History: Development as in S. filaria; accessory causes as in filaria substituting bovine for ovine victim, and source. Lesions: Bronchitis, muco-purulent exudate with worms and ova, lobular congestion of lungs, miliary nodules as in sheep. *Symptoms:* Bronchitis or pneumonia, in whole young herd, without climatic cause, or special fever, cough, first hard, second wheezing or mucous, free expectoration with worms or ova, anorexia, debility, emaciation, anæmia, dry, scurfy, hide-bound skin, sunken eyes, leaves herd, prey of flies, diarrhœa. Diagnosis: Above symptoms under conditions favorable to the worms. Duration, 10 to 90 days. *Prevention:* As for lung worms in sheep, cattle being substituted. *Treatment:* As for sheep, but more active.

Like the corresponding affection in sheep, this is prevalent in certain localities, and causes extensive losses in young calves under a year old. Older cattle may harbor the worms, but rarely or never suffer to a fatal extent. The disease is caused by two species of worms—**strongylus micrurus** and **strongylus pulmonaris**.

Strongylus Micrurus: Pointed tailed strongle. This is a delicate white filiform worm having a rounded, wingless head, and terminal, round, nude mouth. The *male* is 1 inch and the *female* 2 to 3 inches long. The caudal membrane of the male is small and supported by five ribs on each side, the posterior trifid, the anterior bifid and the middle simple. The tail of the female is sharply pointed, and the vulva in the posterior sixth of the body. Ovoviviparous.

Habitat. The bronchia of bovine animals especially calves. It was supposed to infest horses and asses as well, until the strongylus Arnfieldi was demonstrated to be distinct.

Strongylus Pulmonaris. This is smaller than the Strongylus Micrurus (7 lines to 1⅓ inch long), and its terminal mouth is surrounded by a row of rounded papillæ. In the male the caudal membrane is bell-shaped, with 7 rays. The tail of the female is very attenuated and sharp. Ovoviviparous.

Habitat. Bronchia of bovine animals, especially calves.

History of the Disease. The existence of lung worms in calves was noted in 1744 by Ruysch, in 1756 by Nichols, in 1803 by Camper, and very frequently since.

Life History. Development. This has not been fully traced for the lung worms of cattle but it may be assumed that the development closely resembles that of the strongylus filaria. The eggs and embryos expelled in coughing live for a time in fresh water or moist earth, where there is reason to believe that they moult or undergo other change that fits them to once more take up the life in the bronchia. They do not persist indefinitely, generation after generation in the same animal's lungs, and hosts that harbored them when calves, are usually free from them before they reach maturity.

Conditions that Favor Infesting are essentially the same as for the lung worms of sheep. Wet lands, and seasons, inundations, fresh water in puddles, ponds, lakes, swamps, streams and open wells, dry seasons after wet, water-shed, overstocking, low condition, ill health, starvation, youth, etc., are prominent accessory factors. Leuckart and Kasparek have separately preserved the ova for 2 to 3½ years, with the embryos still alive, showing the need of prolonged abandonment of infested grounds, streams, ponds and buildings.

Lesions. The congestion of the bronchial mucosa is intense, the lumen is often blocked with a frothy muco-purulent matter containing ova, embryos and the mature worms, singly or in bundles. Lobular congestion of the lungs is frequent, and the surface may show grayish pinhead-like granular nodules like those seen in the sheep and resembling miliary tuberculosis. At other points particular lobulettes are collapsed and carnified as the result of blocking of their bronchia and expulsion of the air.

Symptoms of Verminous Bronchitis in Calves. The symptoms are those of bronchitis, or, in the worst cases, of pneumonia, plus the expectoration of an abundant frothy liquid containing the ova, embryo, or mature worms. Usually they advance slowly attacking nearly all the young bovine animals, without any special change of weather or particular exposure. In the milder cases there is a slight cough for a week or two or perhaps only some sign of hurried breathing when driven or excited. Soon the cough becomes more frequent and paroxysmal, threatening and perhaps actually causing suffocation. Short of a fatal result the animal may fall with extended head, open mouth, protruded tongue, frothy discharge from the mouth and bulging eyeballs. The cough may be at first hard, but usually becomes loose and mucous, or wheezing, and a loud wheezing may be heard over various parts of the chest on auscultation. The calf loses appetite, strength and condition, becomes hide-bound, with dry scurfy skin, staring coat, absence of subcutaneous fat, pale mucosæ and sunken eyes. It wanders off alone, and is found lying under a tree or bush or in the corner of a fence covered with flies, which it has no longer the energy to brush off. It may be purging because of worms in the bowels. The patient that escapes asphyxia may die of marasmus.

Diagnosis is based on the occurrence of the disease simultaneously in the majority of the herd, without apparent exposure or meteorologic cause, and at first without appreciable hyperthermia, on the knowledge of the existence of the parasites in the pastures or district, on the damp or otherwise favorable condition of the pastures, on the importation of strange cattle from infested regions, on the absence of large continuous areas of consolidated lung (as in lung plague or croupous pneumonia), on the absence of implication of the lymph glands and of mature cattle (as in tuberculosis), on the presence of numerous small areas of wheezing in the lungs, and of limited areas of dulness on percussion, and above all the presence of mature or embryo worms or eggs in the expectoration. This last, the only real diagnostic symptom may be hidden by the habit of swallowing the expectoration, and it may become necessary to pull out the tongue with the left hand, while with the right the larynx is tickled to arouse the cough, and the mucus is seized and withdrawn as soon as it is coughed up.

Duration of the disease will vary in the affected calves, which live two or three months in the milder cases, while in the more severe, death may ensue in ten or fifteen days. It must be borne in mind that death may occur at any time from blocking of the bronchi.

Prevention. This is essentially the same as in the case of the lung worms of sheep, with the simple qualification that the worms in this case are known to infest cattle only, and thus horses and sheep may safely occupy the pastures that have been infested by cattle, and cattle may safely feed on lands contaminated by horses and sheep. Bearing this in mind as a qualifying principle, the same precautions may be taken as regards soil, drainage, puddles, ponds, lakes, rivers, open or shallow wells, swamps, manure, rotten wood work, infested strange animals, overstocking, dry seasons, low condition, youth, etc., (see *Prevention of Lung Worms in Sheep*).

Treatment. This also is the same as in the sheep (which see). The calf is, however, a stronger patient and may be treated somewhat more vigorously. Neumann and Jauné succeeded with asafœtida 4 ozs., Chabert's empyreumatic oil 8 ozs., mucilage 1 qt.: Dose ½ oz. daily for a month, in milk. Read succeeded with a mixture of sulphuric ether 2 ozs., and oil of turpentine 1 dr.: Dose, 2 teaspoonfuls poured into the nose with the head elevated, and repeated for several days. Chloroform and rectified oil of amber were equally effective. Kriwonogow succeeded with oil of cloves and oil of turpentine 3 ozs. of each, carbolic acid and olive oil 2 drs. of each: Dose, 2 drachms, intertracheally. Hutton used oil of turpentine 3 ozs.; laudanum, carbolic acid and water 3 ozs.: Dose ½ oz. intertracheally, every day, or every second or third day according to urgency. Benzine 2 drs. intertracheally has proved best in my hands. Williams recommends Scheele's prussic acid: Dose, drops 10 to 20 with carbonate of soda and gentian twice a day, in draught. A more uniform strength and greater certainty of result can be secured by substituting potassium cyanide in doses of 1 grain in watery solution, which may be injected into the trachea. The deadly nature of the acid and cyanide demands extreme care in its use. A liberal use of onions, garlic or leeks will materially contribute to check the disease. Bronchitic and pneumonic com-

plications are to be met by appropriate measures, as in the sheep, and in every case the use of rich feeding with iron and bitters will be desirable. The treatment of intestinal worms is equally important.

ACTINOMYCOSIS OF LUNGS OF CATTLE.

See *Actinomycosis*.

STRONGYLUS ARNFIELDI. LUNG WORM OF THE HORSE, ASS AND MULE.

Worm 1 to 1¾ inch long; caudal membrane of male with ribs bifid, the posterior bilobate; tail of female a blunt point; ovoviviparous; ova elliptical; embryos with thin diaphanous tail. Host: Bronchia of solipeds. Embryos have poor vitality, dying in seven days in pure water, hence worm rarely abundant. *Symptoms:* Hard or mucous paroxysmal cough, wheezing developed by exercise, and expectoration of worms or ova. *Prevention* and *treatment* as for lambs and calves, changing the host. *Sclerostoma Equinum* in vessels of lung. *Pneumo-mycosis in Solipeds.*

This is a small, white, filiform worm, of nearly the same size as the strongylus rufescens; *Male* 1 inch; *female* 1½ to nearly 2 inches long. The mouth, terminal, round or ovoid, is devoid of papillæ. The caudal membrane of the male is short and slightly festooned, with the anterior rays bifid, the forward branch being the shorter, the middle rays bifid with branches equal in length and the posterior rays bilobate at the ends. Two spicula, equal, arched, reticulated and a third small spiculum. Tail of female slightly curved and attenuated, but ends in a blunt point. Vulva in front of the posterior fifth of the body. Ovoviviparous. Ova elliptical. Embryos 450μ with thin diaphanous prolongation.

Habitat. Bronchia of solipeds—horse, ass, and mule.

They are much less common than lung worms of calves and lambs, which has been explained by the low vitality of the embryos. Railliet found that these died in seven days in pure water. An almost constant internal existence appears to be needful to their preservation. Yet they attain a considerable prevalence in favorable localities. Morier found them in Switzerland in horses of all ages, Eichler and Guelt in Berlin and Arnfield in London. The author found them to be exceedingly common in donkeys,

old and young, brought from the low damp lands at Hammersmith, London, for dissection. In none of these cases, however, did they attain to the ruinous extension which belongs to the lung worms of sheep and cattle.

A hard or mucous paroxysmal cough, with short and wheezing breathing, developed by exercise, and the expectoration of the worms and their embyros, have characterized the disease. The lesions are of the same nature with those caused by lung worms in sheep, and with a dense aggregation of equine hosts, under circumstances peculiarly favorable to the preservation of the embryos and their ingestion in water or otherwise, the worm could well start a local epizoötic.

The general measures of *prevention* and *treatment* are the same as for lambs and calves, account being taken of the fact that this parasite cannot be conveyed to these animals, nor the lung worms of the ruminants to solipeds. Horses can safely graze on pastures infested with the lung worms of sheep and cattle, and ruminants may be turned out on those that are infested with strongylus Arnfieldi.

SCLEROSTOMA EQUINA IN HORSE'S LUNG.

This parasite which, in its sexually immature condition, invades the blood vessels, has been found on two different occasions in the horse's lung by Lammers and Michalik respectively. In the case recorded by the latter there was resultant pulmonary hæmorrhage.

PNEUMO-MYCOSIS IN SOLIPEDS.

See Aspergillus in Birds.

VERMINOUS BRONCHITIS IN SWINE. LUNG WORMS IN PIGS.

Strongylus Paradoxus: Six labial papillæ ; 5 to 12 lines long ; male caudal membrane has five ribs ; female wlth sharp pointed, curved tail ; oviparous or ovoviviparous, ova elliptical with folded embryo. Host : Bronchia of pig (sheep ?). Development as in filaria. History. Lesions as in sheep. *Symptoms :* Obscure, unthrift, anæmia, emaciation. paroxysmal cough, in most of young in herd, expectoration containing worms or ova ; recoveries

common. *Treatment* as for sheep. *Prevention:* Change pen and range; avoid all, possibly contaminated, pond, stream, or well water, boil all water given; keep on wooden or cement floors, moderately salt all food, separate infested from uninfested; wean and separate young pigs early.

This affection, caused by **strongylus paradoxus** has been little noticed, yet it is far from uncommon in young and growing pigs, though almost unknown in the adult animal.

Strongylus Paradoxus (Mehlis). **Strongylus Elongatus** (Duj.). **Lung Worm of Swine.** Delicate filiform worm, white or brownish. Mouth terminal, round, with six papillæ. *Male* ½ to ¾ inch, *female* 1 to 1 ¼ inch long. Caudal bursa of male deeply bilobed each lobe supported by five rays. Two long, delicate spicula. Tail of female curved, with sharp point. Vulva on a pre-anal tubercle. Oviparous, or ovoviviparous. Ova elliptical with contained embryo folded several times.

Habitat. Trachea and bronchia of pigs, wild and tame. A. Koch claims to have found them in sheep.

The *development* of the parasite has not been traced but is probably similar to that of the strongylus filaria and is favored by similar local conditions, allowance being made for the fact that the ravages of the worm are confined to swine only.

History. Toward the end of the 18th century this worm was found by Ebel, Goeze, Modeer, Mehlis, etc., and early in the 19th century by Bellingham, Dujardin, Rayer, and Chaussat, first in the Paris abattoirs and by Bellingham in those of Dublin, Chatin found them to be common in France, Boudeaud, in the department of Indre, and Modena in Sardinia and the Maremmes of Tuscany. The author has frequently found them in unthrifty pigs and shoats in Central New York.

The *lesions* are essentially the same as those of verminous bronchitis in sheep, the number of parasites determining the extent and violence of the morbid process. Collapse and congestion of particular lobules are not uncommon and Gratia describes the appearance as of miliary tubercles, resembling those seen in sheep with the strongylus rufescens. These are due to the encystment of the female worm or of the ova and embryos in the air sacs and cells. Invasion of the lungs by numerous cysticercus tenuicollis may give rise to similar pneumonia, which may be differentiated by the microscope. (Leuckart, Zschokke, Boudeaud).

Symptoms are often obscure. Unthriftiness, lack of condition, anæmia and emaciation are shown especially in young pigs, and if associated with a paroxysmal cough, at first hard and later moist and rattling, or even suffocating, and if this shows in a large proportion of the herd independently of any change of weather, damp bed, or other cause, there is a strong presumption of lung worms. This may be confirmed by finding embryos or adult worms in the frothy expectoration, or, in fatal cases, in the bronchia. Death may be from suffocation, or from progressive emaciation and marasmus. In the majority of cases, however, the disease subsides and the patient recovers, so that its true nature is never discovered.

Treatment is the same as for calves or lambs, tracheal injections of benzine or oil of turpentine being especially to be recommended. (Block).

Prevention is to be sought in a change of pig-pen and range, and the careful avoidance of pond, running or well water which may have become contaminated by the affected herd or by others, or better still in boiling all water before it is supplied to them. Such measures are especially necessary in the case of young pigs, which almost alone furnish fatal cases. These may be kept on fresh ground, or, if the sows are affected, on wooden or cement floors, the food should be moderately salted, and they should be removed from the sows and all mature swine as soon as they are weaned.

VERMINOUS BRONCHITIS IN RABBITS AND HARES.

Rare except in wild rabbits. *Strongylus Commutatus:* Mouth with 3 papillæ; ⅔ to 1 inch long, male caudal membrane two-lobed with 10 ribs; female with curved pointed tail, vulva on pre-anal papilla. Hosts: Bronchia of wild hares and rabbits. *Symptoms:* Hurried breathing, cough, frothy, worm-bearing expectoration, dyspnœa, anæmia, emaciation. *Treatment:* Mainly preventive; raise young on artificial floors till weaned, then give sound warren.

This has been found in the wild rabbit and hare and has been rarely seen in the warren rabbit raised for the market. Yet it only lacks favorable conditions for the propagation and preserva-

tion of the worms, to develop a plague where the domesticated rabbit is raised in crowded warrens with ground floors. The facts that such warrens are usually on dry ground, or on artificial floors, and that they are comparatively uncommon, may account for the habitual exclusion of the offensive parasite.

Strongylus Commutatus. A worm with rounded head and circular mouth with three papillæ. The *male* is ⅔ to 1 inch and the *female* about 1 inch long. The former has caudal bursa bilobate, each lobe having 5 rays and two very long slender spicula. The female has a pointed curved tail, and the vulva on a pre-anal papilla. Oviparous and ovoviviparous.

Habitat. Bronchia in wild rabbits and hares.

The *symptoms* are hurried breathing, cough, frothy expectoration containing worms, dyspnœa, emaciation, anæmia.

Treatment would be on the same lines as for other animals, but should be especially preventive, including careful separation of the sick and healthy or the destruction of the former and the raising of the latter on uncontaminated ground on sound food and water. A valuable race may be preserved by keeping the young on artificial floors till weaned and then placing them in a fresh sound warren.

VERMINOUS BRONCHITIS AND PNEUMONIA OF THE DOG AND CAT.

Strongylus Vasorum: ½ to ⅔ inch long, skin diaphanous, showing spiral, reddish digestive canal; head alated, no oral papillæ; male caudal membrane bilobed, eight-ribbed; female with curved, blunt tail, ova elliptical. Habitat: Heart cavities, pulmonary vessels, embryos in bronchia. *Lesions:* Semi-transparent, miliary nodule, of round cells with ovum or embryo; adjacent lung gray. Embryos taken in food and water develop into digestive organs and veins, mature in heart, arteries, capillaries. *Symptoms:* Fits of dyspnœa coincident with embryonic development; embryos in expectoration. *Treatment* and *prevention:* Restrict to boiled water, salted meat; oil of turpentine, arsenic.

The dog harbors a variety of worms in the lungs, which may give rise to similar pathologic phenomena.

Strongylus vasorum. A delicate, cylindroid worm smaller toward the ends, *male* ½ inch, *female* ⅔ inch long, whitish or

pink and having an interrupted reddish spiral representing the digestive canal shining through the skin. Head with two alæ; mouth round, naked, terminal. Male has caudal membrane in two lobes each having four rays, the anterior and third bifid, the second and fourth simple. Two equal spicula. Female with blunt, slightly curved tail, and vulva near its tip and close in front of the anus. Ova elliptical.

Habitat. Cavities of the heart and pulmonary blood vessels of the dog.

History. Lesions. These were found by Dujardin in 1812 in the heart of a dog at Paris. Serres records the death of a dog from an immense number of these worms in the right auricle and blocking the pulmonary artery even to its smallest divisions. In the heart they seem to find shelter in the recesses beside the columnæ carnæ, where they cause erosion of the endocardium, granulations and fibrinous deposits and clots. The embryos are found in the bronchia as has been demonstrated by Laulanie. The ova, laid in the pulmonary artery and its branches, are arrested in the arterioles and capillaries, and there the embryos are hatched out and in part escape into the air tubes. The irritation caused by the ova and embryos in the capillaries, determines active cell proliferation and the formation of a semi-transparent nodule, like a miliary tubercle, consisting of embryonal and epithelial cells with the ova or worms in the centre.

The general aspect of the affected portion of the lung is a pearly gray, but with a lens the distinct granules can be seen and by teasing out one of these the ova and embryos can be detected under the microscope. In this way these granules may be easily distinguished from genuine miliary tuberculosis.

Laulanie deduced from experiments in feeding dogs the infested lungs, that the expectorated embryos are taken in by other dogs in food or water, and undergo partial development in the digestive organs or veins, so that they can attain maturity in the heart and pulmonary artery.

Symptoms. These consist in attacks of dyspnœa referable to the blocking of the pulmonary capillaries, and which are intermittent or remittent, coinciding with the attaining of maturity by a generation of females, the laying of eggs and the hatching of a crop of embryos. Death may occur during one of these at-

tacks, or at other times from interference with the action of the heart, or the patient may recover providing the introduction of fresh embryos is prevented. Labat notes a systolic blowing sound in the femoral artery. The best diagnostic symptom is the discovery of the embryos in the frothy mucus expectorated.

Prevention and Treatment. In localities where these worms prevail, precautions should be taken against the lapping by dogs of water from puddles where affected dogs have preceded them. Giving boiled water would be the safest course. Salted food would also tend to destroy the embryos. Lafosse believed that he destroyed the worms by giving ½ to 1 dr. oil of turpentine in pill form daily for a week. Labat claimed equal success with Bordeaux turpentine, ½ to 1 dr. daily with calcined magnesia or yolk of egg. Fowler's solution of arsenic, 10 drops daily, might also be tried.

Strongylus pusillus. The ovigerous female lays its ova in the lung of the cat where the embryos are hatched, giving rise to inflammation points varying in size from a pin head to a hemp seed and resembling miliary tubercle. In groups they may be the size of a pea, or by coalescence they may cause patches of gray hepatization. Scraping of these pneumonic centers furnishes ova and embryos, but it is only very exceptionally that the parent worm is discovered. The mature worm disappears after depositing her ova. Neumann found this infestment in one-fourth of the cats examined. It causes paroxysmal cough, vomiting, and in bad cases staring coat, diarrhœa, emaciation, and marasmus with death in two months or more. It may be treated by tracheal vermifuge injections as in the larger animals.

Ollulanus Tricupsis. The larvæ of this worm of the cat may invade the lungs as well as other tissues and the resulting lesions are easily confounded with those caused by the pusillus. There are however no parent ovigerous worms and no ova.

Trichosoma (Eucoleus) ærophilum. This is a hair-like worm. *Male* 24 mm., female 32 mm., 100 to 180μ thick and attenuated towards the ends, especially the caudal one. *Male* has truncated tail, bilobed pouch, and one spiculum, with spinous surface. It infests the trachea and bronchia of fox, marten and cat.

PARASITES OF THE AIR PASSAGES AND LUNGS OF BIRDS.

Aspergillus, black, green and white. *Prevention:* Separate infected birds, burn their carcasses, clean house and run, spray walls, floor, etc., with mercuric chloride, wash with chloride of lime, bluestone, scald dishes. *Treatment:* Fumigation; wood tar, sulphur fumes, creolin, cresolin, terpinol, naphthalin; inject into larynx hydrogen peroxide, potassium iodide, sodium bisulphite. *Aspergillus in cows:* Nodules with mycelium, anorexia, agalactia, cough, grunting. *Aspergillus in horse:* Nodules with mycelia in lung, liver, guttural pouch. *Fungi in dog's lung, spleen and kidney:* Cough, dry, hurried breathing, lameness behind, emaciation. Treatment as in fowl. *Botriomycosis in horse's lungs: Treat* as for aspergillus.

The parasites of the respiratory organs in birds belong to both the vegetable and animal kingdoms. A cryptogam gives rise to a mycosis of bronchia, air sacs or pulmonary tissue; acari determine acariasis of the connective tissue and air chambers, and passages of the air sacs, lungs and bronchia; and the sclerostoma syngamus lives in the trachea and bronchi, causing the deadly syngamosis or gapes of the young.

PNEUMO-ASPERGILLOSIS; PNEUMOMYCOSIS; ASPERGILLUS DISEASE OF THE AIR PASSAGES. (See page 59.)

In Prevention and treatment the following may be inserted here:—

Prevention. Every effort must be directed toward the destruction of the aspergillus. Secure the removal of affected birds and the incineration of the carcases, the absolute cleanliness of the poultry house and yard, the liberal spraying of walls, roosts and nests with a solution of mercuric chloride, chloride of lime or cupric sulphate. Thereafter the roosts should be frequently washed with the solution of bleaching powder or of cupric sulphate. As an application preliminary to the above, the exposure of the whole surface of the building and its contents to a jet of live (transparent) steam, or a deluge of boiling water proves excellent. At intervals the fowls may be turned out and the house closed and filled with sulphurous acid or chlorine gas, for several hours. The floors and yard, or run, should be frequently sprink-

led with freshly burned quicklime, or a solution (5:100) of copperas or sulphuric acid. The drinking and feeding dishes should be filled every few days with water at the boiling temperature and allowed to stand until cooled to 150° F.

Therapeutic Treatment. The small value of the fowls individually will often forbid careful treatment of the sick. If otherwise, fumigation is the most promising resort. Neumann advises the vapor of wood tar set free in a close building containing the patients. A spoonful of wood tar is put in a pint of water and stirred with a red hot iron, care being taken to prevent suffocation by making the vapors too dense. Sulphur fumes may be used in the same way, but with all due precaution as birds are very easily suffocated. A safe and effective method is to keep the patients in a close room, having the air constantly but slightly impregnated with sulphurous acid, tar, cresolin, terpinol, or naphthalin. Hydrogen dioxide solution (1:3) may be injected into the larynx and bronchia. Solutions of potassium iodide or sodium bisulphite may be used in the same way. Convalescent birds should not be returned to the main flock until after a considerable lapse of time.

FUNGI IN THE AIR-PASSAGES OF MAMMALS.

Zurn, Schütz, Roeckl, Konig, Mazzanti, Hartenstein, and Piani have noted **aspergillus fumigatus in the lungs of cows.** It caused nodules like hempseed in the substance of the lungs with adjacent pneumonic and even pleuritic lesions. The nodules represented the alveoli and showed mycelium in the centre and radiating outward. They had anorexia, agalactia, weakness, paroxysmal cough, sighing, grunting breathing and the objective symptoms of broncho-pneumonia.

Mazzanti found in a **lamb**, puriform nodules, like hempseed, containing radiating filaments and spores growing outward from the seat of the air cells. These were surrounded by an area of pneumonia or peribronchitis. Schütz, Lucet, Thary, Martin and Rivolta have found nodules in the **horse's lung**, with a surrounding area of pneumonia, and containing mycelia and spores. Similar nodules were found in the liver (Martin), and in the right Eustachian pouch (Rivolta). In Martin's case the horse was destroyed because of a progressive anæmia and emaciation.

The centre of the nodules was in some cases purulent (Martin). There were prostration, tremors, bloody expectoration, cough, and objective symptoms of lung disease.

Rivolta found in the lungs of a bitch a fungoid growth the true nature of which was not demonstrated, but which was present as well in a soft sarcoma of the spleen, kidneys, and left uterine cornu. It had caused a dry, frequent cough, hurried respiration, lameness of one hind limb and extreme marasmus.

The disease is much more rare in the mammal but *treatment* will be along the same lines as in the bird. Antisepsis of the buildings, and especially of mangers, troughs and racks, with fumigations or intratracheal injections would be specially demanded. Cresyl, tar, carbolic acid and oil of turpentine may be sprinkled for inhalation, and carbolic or salicylic acid, or potassium iodide solutions may be injected into the trachea.

BOTRIOMYCOSIS OF THE LUNGS IN SOLIPEDS.

Thomassen, Bollinger and Steiner have reported botriomycosis in the lungs of horses suffering from this affection of the spermatic cord. Nodules the size of a walnut with yellowish caseating centres, and others down to the size of a pin head showed the organism in the midst of the diseased tissue. Its relation to the indurated cord serves to identify it. Treatment would include the removal of the diseased cord, the internal administration of iodide of potassium and inhalations of iodine.

Monostoma Mutabile. A long (5 to 24 mm.) narrow leaf-like fluke found in the suborbital cavities and air passages of geese. While narrow and cone-like in front it broadens to 2 to 8 mm. behind. Sucker nearly subterminal, small, with mouth in the center. Ova brown, 173μ by 84μ, hatching out, in the uterus an embryo containing a sporocyst. May become so numerous as to cause an epizootic, and attack other water birds.

SYNGAMOSIS. VERMINOUS TRACHEO-BRONCHITIS. THE GAPES IN BIRDS.

Syngamus Trachealis: Male and female constantly adherent to each other; female 5 to 20 mm. long, thrice the length of male; mouth bell-shaped with six papillæ or lips; pharynx has six sharp teeth; female has body full of oviducts containing segmented ova; embryos escape by decomposition of female, live in earth, water and earth worms, or escaping in stomach, pass into abdominal air sacs and bronchia, develop to sexual maturity in air-passages. Hosts: Hens, turkeys, pea-fowl, pheasants, partridge, and many wild birds. Young, downy birds suffer most. *Syngamus Bronchialis:* Larger than trachealis; female 15 to 25 mm.; union of male and female not so constant; ovum not operculated. Development as in trachealis, Hosts: Bronchia of ducks, swans, geese. *Symptoms*: young turkeys &c. a few days old; gasp, sneeze, gulp, cough, wheeze, mucous discharge, often containing worm, dulness, drooping wings, inappetence, no fever, worms may be seen through trachea, or drawn out with looped hair. *Mortality* often 80 per cent. of young. *Prevention*: Give older birds a change of run. Hatch out in incubator and keep on paved floor till fledged, or on quite new run; boil green food and water; soak runs and floors with strong common salt solution, or sprinkle with a vermicide; wash drinking and feeding dishes twice daily. Burn infested carcases; exclude wild birds. *Treatment*: Extract worms with a twisted loop of horse-hair dipped in camphor, ol. terebinth, salicylic acid, or salt solution; smear the breast with asafœtida, camphor, turpentine, or naphthol to be inhaled; tobacco solution or smoke.

This is a catarrhal affection of birds and especially of the young, caused by one of two round worms, (*syngamus trachealis*, and *s. bronchialis*), armed mouthed (sclerostomes), of the family of Strongyli.

Syngamus Trachealis. (Sclerostoma Syngamus, Diesing). The peculiarity of this worm is that the two sexes, male and female, are permanently united by the attachment of the caudal end of the male to the vulva of the female situated in its cephalic third, so that they appear as if one organism and have been called the *forked worm*. The *female* is from 5 to 20 mm. long, about three times the length of the *male*, and over twice the thickness. The mouth is orbicular, bell-shaped, and bounded by six expanding papillæ constituting a sucker. The pharynx has six or seven chitinous lancet-shaped teeth. The *male* has at its caudal end a bell-shaped bursa having about 12 ribs, and con-

stantly attached around the vulva of the female. The *female* has its body filled with oviducts convoluted largely in spiral so as to give a contorted appearance, and containing ova in all stages of segmentation. The tail is a blunt cone.

The *embryos* do not escape from the egg until the death, and decomposition of the female makes a way of escape for them. In the moist earth, in water and in earth worms they are found in the form of minute thread-like worms (like anguillula). When the parent worm has been expectorated it may be again swallowed by a bird, or the free eggs or embryos may be taken in in food or water. In the stomach and intestine the envelopes are digested setting free the embryo, which is supposed to bore its way into the abdominal air sacs, and pass thence into the bronchia. In the air passages they pass through their first transformation and the sexes are differentiated by the formation in different individuals of male or female organs. When male and female unite they are of equal size, and the subsequent extreme development of the female is in connection with the extension of oviducts and formation of ova.

Birds susceptible. A long list of birds, wild and tame, harbor the *syngamus trachealis*, such as hens, turkeys, pheasants, partridges, pea-fowl, magpie, black stork, hooded crow, chocard, parrot, starling, swift, woodpecker, sparrow, marten. The young downy birds suffer most.

Syngamus Bronchialis. This is a rather larger worm than the *syngamus trachealis*, the *male* being 10 mm. long and the *female* 15 to 25 mm. The union between the two is not so constant and the caudal end of the female is more pointed. The elliptical ova, 90μ long are not operculated as in the *trachealis*. The ribs of the male caudal bursa have the two posterior trifid. They enter the avian body as do the trachealis.

Birds susceptible. This worm has been found in the bronchia of ducks, swans, and European and Japanese geese.

Symptoms. Young turkeys and chickens, a few days old, are found to open the mouth frequently, gasp for breath, sneeze and attempt to swallow. This has secured for the disease the name of "*gapes*." Breathing is oppressed and wheezing, accompanied by an abortive cough, the mouth is filled with glairy mucus, in which the expectorated forked worm may sometimes be found,

the patient is dull, with drooping wings. Appetite may or may not be impaired. There is little or no fever, but emphysema of the neck and chest has been noted (Reune). It is claimed that the worm can be seen by holding up the bird between the eye and the sun and looking through the trachea. It can often be drawn out by a loop of horse hair turned round in the trachea and withdrawn.

Mortality. This is greatest in the small downy chicks, and if the patient survives until partly fledged it will often recover. Wiesenthal who first noticed the disease near Baltimore in 1797 states that it destroyed 80 per cent. of the fowls on many old established farms. Crisp says it kills 500,000 chicks yearly in England, and Megnin that it has destroyed 1200 young pheasants daily in the hatching establishment at Rambouillet.

Prevention. For the *older birds* a change of run will greatly diminish the number of parasites harbored. For the *young birds*, hatched out in the incubator, keep on a poultry house floor until well fledged. Give them no water until it has been boiled and no green food from an adjacent or suspected soil. I have known hundreds of chickens raised safely in one year on a farm, where the previous year all had perished out of doors with "*gapes.*" For the *whole flock* the following are important prophylactic measures: Sprinkle the runs with gas-lime and camphor, soak the runs or floors with a strong solution of common salt, or sprinkle with carbolic acid, kerosene, sulphuric acid solution (1:100) or salicylic acid solution (1:100). Wash out drinking and feeding dishes twice daily and treat them with one of the above solutions. Boil all water and green food before supplying it. Salicylic acid (1:100) or rue or garlic in the drinking water destroys the embryos taken in. The carcases of dead birds must be burned or boiled, and the houses and runs must be kept scrupulously clean, to prevent the ingestion of expectorated worms. Wild birds that are likely to harbor the parasite must be as far as possible excluded from the houses and runs.

Treatment. A number of worms may be extracted by a feather stripped of all its plumules except a mere tuft at the tip, or better by a stiff horse hair doubled upon itself and twisted up so as to form a fine loop. This is passed into the opening of the trachea in the centre of the root of the tongue, and, when well

down, turned around several times and withdrawn, when one or more worms will usually be found attached to it. This may be repeated at intervals until the bird appears to be permanently relieved. To render this more effectual the extractor is sometimes dipped in camphorated spirit, tobacco solution, oil of turpentine, salicylic acid solution, sulphurous acid solution, olive oil, salt solution or other non-irritating vermicide. It must not be pushed too urgently, nor continued too persistently at one time, as the young bird is very easily asphyxiated.

Cobbold rendered the bird insensible by a drop of chloroform, and slit up the trachea and extracted the worms with forceps. The wound was stitched up, any emphysema relieved by needle puncture and healing took place by first intention.

Volatile vermifuges that are exhaled by the lungs are especially useful. Thus garlic, onions, asafœtida and even ginger in combination with gentian in the food or water, destroy the embryos in the alimentary canal and often also the mature worms in the air-passages. Spirits of camphor or oil of turpentine, smeared on the downy breast so as to be inhaled, operates well, and may be introduced into the trachea on a feather. Tobacco, salicylic acid solution, kerosene or benzine may also be used in the trachea. Sulphurous acid or salicylic acid, or sodium salicylate solution (5: 100) may be introduced through the larynx, or the fumes of burning sulphur may be inhaled largely diluted in air and with extreme caution. Tobacco smoke may be blown under a cloth covering the birds until they fall over inanimate, when the cloth is removed and they revive in the open air. Other vermifuges may be employed in a similar manner, special care being taken to avoid asphyxia to which birds are so prone.

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PARASITES OF THE CIRCULATORY SYSTEM.

HÆMATOZOA IN THE HORSE.

The blood of the horse is the home of the **Trypanosoma Equiperdum** of Dourine, the **Tr. Evansi** of Surra, the **Tr. Brucii** of Nagana and the **Tr. Equinum** of the Mal de Caderas. (See Vol. IV).

Among nematodes the **Sclerostoma Equinum** is the most common, forming aneurisms in the mesenteric arteries, cœliac axis, renal and spermatic arteries, and even invading the posterior aorta, portal vein and other blood vessels (see Vol. II); the **Spiroptera Reticulata** found in the arteries of the metacarpus or metatarsus, and those on the side of the cervical ligaments; the **Filaria Papillosa** which is so common in the serosæ (see *parasites of the intestines in the horse*); and the **Filaria Sanguinis Equi** found by Sonsini in the blood of Egyptian solipeds. The species of the last filaria is uncertain. As the same animal had filaria papillosa in the peritoneum it is plausibly suggested that these were the larvæ of that worm, the more so that Wedl found a similar coincidence. Jakimoff of Kazan found 1 or 2 nematode embryos in each drop of blood of a horse suffering from hæmaturia and which made an early recovery. Again Mazzanti of Pisa found nematode embryos in the hepatic vessels of a horse and which he believed to cause nodules in the hepatic tissue. These he alleges were quite different from the embryos of filaria papillosa. These minute round worms varied in different cases from 10 to 180μ in length, and from 2.85 to 5.7μ in thickness. The well-known migratory habits of several of the nematodes of the horse must leave in some doubt the identity of minute agamous worms which may be the embryos of one or other of these mature forms.

VERMINOUS CUTANEOUS HÆMORRHAGE IN THE HORSE. DERMATORRHAGIA PARASITICA.

Bloody sweat appears to have been known in the horses of Khodang, China, from remote antiquity (Leymacher). It was noticed in Italian horses in 1860 (Ercolani), and later in Hungary and Spain by different observers. The most important contribution to the subject was made in 1877 when Drouilly and Condamine demonstrated in the bleeding cutaneous nodules, a fine thread-like worm (**Filaria Hæmorrhagica, F. Multipapillosa**). Other European records trace the cutaneous hæmorrhages especially to eastern horses; Barthélmy Sr. to the Steppe horses in the wars of the first Napoleon; Spinola thought it peculiar to the Steppe breed; Sibald to the white horses of Tartary. Leymacher and Fleming saw it in Hungarian horses; Fleming in Arabian

horses, and in Indian horses in North China; and Liautard in Spanish horses and mules in Algeria. Cutaneous hæmorrhages have also been seen in the ox but these have not been definitely connected with filaria as the cause.

Filaria Hæmorrhagica. The *female* worm only has been found so that neither the morphology of the male nor the life history of the parasite can be furnished.

The female is 2 inches long, .355 mm. thick, of uniform size in the anterior two-thirds, and tapering in the caudal third toward the tail. The mouth is terminal, round, nude, and the anterior part of the body bears numerous minute, conical, wart-like papillæ. Vulva in the anterior third. Oviducts very largely developed and containing an extraordinary number of ova and free embryos. Ovoviviparous.

They probably enter the body in food or water and bore their way from the alimentary canal to the dermal and subdermal connective tissue. Railliet injected a large number of embryos under the skin of a mare but no morbid result followed, from which it has been inferred that the parasite must pass through earlier stages of development outside the equine body to fit it for the internal habitat.

Symptoms. The first obvious symptom is the eruption on the skin of groups of nodules, in size from a pea to a hazel-nut, hard, resistant, and painless, surrounded by a slight œdema, and surmounted by the erection of the hair in tufts. These nodules appear mainly on the sides of the trunk, but may show on any part of the body or limbs. The eruption, which appears quite suddenly, is partly the result of exudation, but mainly of the extravasation into the surface layers of the derma, and beneath the epidermis. In the centre of the nodule it bursts through the cuticle and dries into a reddish scab around the erect tuft of hairs. The bleeding may occur an hour or two after the formation of the nodule, and the latter promptly subsides, leaving the skin nearly smooth, but for the adherent, dried blood clot. A succession of nodules, however, appear day after day in a group suggesting the successive lesions caused by one or several parasites, in the same situation. The groups of nodules may be kept up for several weeks by successive formations, or they may subside in a few days to reappear after an interval of three or four weeks.

They are usually confined to the three or four months of spring, and disappear absolutely in the winter.

The eruption, however, recurs in the same horse in the following spring, and in England and Central Europe it persists only for three or four years, a permanent recovery being made. It may be plausibly inferred that the parasite does not find out of the body the conditions necessary to its preservation or possibly to its evolution, as they are found on Hungarian and Russian Steppes, and in densely populated China. We have as yet no clear evidence of the propagation of the parasite from horse to horse in Central Europe, even in cases where the equine population is dense.

Diagnosis is completed by the discovery of the filaria. The skin should be shaved as soon as the nodules appear, and on the summit of each elevation will be seen an ecchymotic point. When this spot is well developed, and before it has ruptured it is laid open to a limited depth with a sharp scalpel, when the worm will be detected in the act of drawing itself back into the deeper layer of the skin, or subcutaneous connective tissue. Drouilly advises to place a drop of oil of turpentine on the nodule and watch the position and movements of the worm as manifested by the ecchymotic streaks, or feel it as a firm cord under the tip of the finger. It may sometimes be necessary to follow the line of congestion and extravasation as deep as the muscles in order to find the worm. When a nodule has subsided another may be confidently looked for about ½ inch from the same point within twenty-four hours.

As a rule the general health is not seriously affected. The main trouble is that the tender spots will not bear the harness. Yet suppuration may occur (Lamy), and debility and death have been reported for affected horses and mules (Brunswig, Liautard).

A speedy subsidence of the individual nodule is always to be expected, and the tendency to further eruption disappears with the advent of cold weather or winter. Though it recurs for several years in succession on the coming of spring, yet in three or four years a permanent recovery takes place, the parasite having presumably reached the limit of its existence and perished.

Treatment is mainly paliative, the affected part of the skin being kept scrupulously clean by sponging, and friction by the

harness being carefully avoided. Rest may thus become essential. Strong vermicide solutions like potassium sulphide, quassia, wormwood, or naphthalin may be applied to the skin, and a generous diet and a course of tonics, such as arsenic may be desirable.

FILARIA MEDINENSIS. FILARIA OF MEDINA. F. ÆTHIOPICA. GORDIUS MEDINENSIS. DRACUNCULUS PERSARUM.

The **Guinea Worm**, as this has been called, because of its prevalence on the Guinea Coast, Africa, has been generally treated as a parasite of man, and yet it has been repeatedly found in the dog, the horse and even the ox.

Distribution. It is a denizen of the tropics, and not confined to W. Africa and Arabia as its popular names would imply, but is well-known in Upper Senegal, Senaar, Darfur, Kardofan, Abyssinia, Nubia, Egypt, Arabia generally, Hindustan and China. To the New World it is alleged to have been carried by negro slaves, and is now domiciled in Guiana, Curacao, Brazil and Buenos Ayres.

The female **Filaria Medinensis** is a thin white worm of great length, 18 inches to 2 feet, (in exceptional cases 12 feet), and .5 to 1.7 mm. thick. The head is rounded, and covered by an irregular shield, elongated transversely, and perforated in the middle by the triangular mouth furnished with two papillæ, one above and one below, and behind the latter, six others. The tail ends in a short blunt point, curved into a hook on the ventral aspect. The digestive canal, well developed in the young, becomes atrophied in the mature worm, especially behind where it no longer reaches the anus. The oviduct is very large and gorged with eggs and embryos, but it is no longer connected with an external opening, and the young can escape only by the rupture of the body of the parent. The embryos are of uniform thickness in the anterior ⅔ ds., but taper to a fine point in the posterior third. They are .5 to .75 mm. long by 15μ to 25μ thick. The male worm is not found in the subcutaneous tissues.

Life History. Fedchenko has traced the embryos into the body of cyclops, a fresh water crustacean, as many as 12 infesting a single host without seeming to materially incommode it. Taken in with the unboiled or unfiltered water, the cyclops is

destroyed and digested in the stomach of man, horse, ox, wild-cat, jackal or dog, and the larval filaria set at liberty.

As the ovigerous female only is found in the tissues, it is surmised that the male and female grow to maturity and copulate in the bowels of the mammalian host, that the male then perishes and is expelled in the fæces, and that the impregnated female bores its way into the tissues, but that it is only after 8 months to 2 years that it makes its appearance in and under the skin. (Neumann). Fedchenko, however, failed to convey the disease by feeding young dogs and a cat with infested cyclops.

Dracontiasis in the dog. This has been seen in India, (Smyttan, Forbes, Griffiths), Egypt (Clot-Bey, Pruner-Bey, Junès and Piot), Buenos Ayres (Doerssel) and Caracao (Doerssel). It may be found in any part of the body but usually affects the legs, forming an oblong tumor, extended parallel to the long bones, and in which the outline of the spirally twisted worm can be felt through the skin. At first painless, this swelling becomes more and more tender and sensitive, the dog shrinks from having it touched, growls and snaps at the person who attempts to do so, licks it frequently, and by restless changes of position or place indicates intense local suffering. The pain is intermittent or remittent, the progress of the disease being marked by periods of rest interrupted by times of extreme pain corresponding to the movements of the worm or the activity of the inflammation. Soon foci of suppuration are developed which burst discharging a seropurulent fluid, and fistulæ are established from one of which the end of the worm in time protrudes. With the appearance of the worm the nature of the case becomes clear. Left to itself the worm would naturally tend to withdraw itself, and decomposing in moist earth or water, would contribute its progeny toward the maintenance of the species. More commonly in his efforts to get rid of it the dog drags upon it with his teeth, tears it in two, or in exceptional cases extracts the whole worm (Piot). When torn across, the imbedded portion retracts itself within the tissues and keeps up the irritation, though, owing to the customary resistance of the dog to pus and other microbes, the gravity of the case is not seriously encreased. Rupture of the filaria in man has been known to induce dangerous infection and even death. As many as five of these worms have been found in one dog.

Dracontiasis in the Horse. In the recorded cases in the horse the worm was found in the limbs, in the lower part of the hind pastern (Clarkson), beneath the carpus (Burke), and on the outside of the hock (Fleming). Fleming's case was in an Australian horse, which had been for some time in India, and a full year in North China before the symptoms were observed. The parasite, therefore, probably entered in India or China. The swelling, at first mistaken for the result of a bruise, was fomented for several days, when it opened, discharging a worm 18 inches in length. Relief was immediate and the horse returned to work in a day or two.

Dracontiasis in Cattle. Avenzoar and DeMarchais speak of the disease as so common in this species in Arabia, that it is described as the *disease of oxen*. The symptoms and course are essentially the same as in other domestic animals.

Prevention. Assuming that the worm enters the body in the cyclops swallowed, prevention would consist in using water from deep, closed and cemented wells only, or in filtration or boiling of the water. Some protection might be secured from the propagation, in the streams, of frogs or fishes which would devour the cyclops.

Treatment. This consists in the extraction of the worm from the tissues. The time honored method has been to seize the protruding end of the worm and to extract it slowly to avoid breakage; or as this is often impossible by reason of the pain and risk, to wind the projecting end of the worm round a small piece of wood or a roll of sticking plaster which is fixed in place by a bandage. At first the worm is stretched as far as it may without laceration and made fast to the roller. Left to itself it extrudes a small portion of its body to relieve the tension and this is wound up at the next dressing, the process being repeated day by day until the whole worm is extracted. This operates well in man, horse and ox, but the dog, suffering more acutely or having less patience, tears the bandage with his teeth and lacerates and releases the filaria. In this animal, therefore, a free incision the full length of the tumor, and the immediate extraction of the worm as a whole is usually preferred. Or the knotted tumor may be incised at different points and the worm extracted in pieces.

The well-known canine indisposition to suppuration or infection tends to obviate evil results and ensure early healing.

SUMMER SORES IN HORSES. DERMATITIS GRANULOSA. BURSATTI.

A granular dermatitis has been long known to English veterinarians in India under the name of BURSATTI as occurring in the hot season following the monsoons, and Fleming, who was familiar with this, identified it with the correspondiag disease seen in Southern Europe and North Africa in summer, and there traced to the presence in the skin of a minute nematode (**Filaria Irritans.**) Bouley described the sores in 1850, as caused by summer heat and special complications, Rivolta in 1868 traced them to the presence of the parasite, and Laulanie in 1884 fully confirmed Rivolta's conclusion. The term *bursatti* is freely applied in America to sores which appear in horses in summer only, and heal up during cold weather, but inasmuch as the worms have not been demonstrated in the American lesions, and the " insupportable pruritus " is habitually absent, one must hesitate to identify the two affections. (See Bursatti, Leeches p. 55).

Filaria Irritans. As we are only acquainted with the larvæ as met in the horse's skin, the true place of this parasite in helminthology, is somewhat uncertain.

" It is a very fine worm which may attain a length of 3 mm. and the head of which is sometimes a little distinct from the body ; the tail is attenuated, terminated in a point and margined by fine notches. The mouth is orbicular and appears to be provided with lips. A short distance from the head is seen an opening. The anus is placed at the point where the body is attenuated to form the tail. The skin is delicately striated transversely." Ercolani found the tapering tail habitually bent under the body and making frequent movements of abduction.

Rivolta believes that the larvæ present in the manure or damp earth bore their way into the skin, and Megnin suggests that they are simply the young of the *Oxyuris curvula*, but there is no sufficient evidence in support of either position. The oxyuris is so common in the intestines, that the *summer sore* should have been far more prevalent, if Megnin's contention were correct. With greater plausibility Laulanie claims that the ovum or embryo

enters the digestive tract from which the young worm bores its way into the skin. Where or in what form it reaches maturity and reproduces its kind is as yet unknown.

The presence of the worm in the centre of the caseous debris of the lesion implies that it is the essential factor of causation. It is not, however, easy to explain the fact that but one horse in a stable suffers for year after year from the local lesions when once started, without any tendency to implicate other horses standing along side or working with him in the team. It would seem as if the disease should be cut short by the death or elimination of the larval worms, and that the other horses in the same stable subjected to precisely the same environment should also contract the affection.

Symptoms. The *summer sores* may appear on any part of the body, but they show a special predilection for parts subjected to friction by the harness, and for the lower portions of the limb from carpus or tarsus downward. They may be individually as small as a millet-seed, or as large as a pea, and in other cases they become aggregated to form patches an inch or even a foot in diameter. The following features are noteworthy : 1. The sores as a rule are active only in hot weather and tend to heal over or to remain indolent through winter or during cold weather, the seat of the lesion remaining as a dry, bare, somewhat elevated spot. 2. After the winter the sore breaks out again on the advent of hot weather, and these alternations are noticed year after year. 3. Though comparatively insensible during the winter quiescent stage, the sores become intensely and insupportably itchy when they become active in the following summer. 4. They tend individually to assume a circular outline, and the centre contains a caseous, fibroid or calcic material in which in the early stages the minute parasite is to be found.

In the active stage they show on the surface a soft pulpy layer, easily removed by the nail, exposing reddish brown granulations and minute alveoli with fibrous walls, which have been supposed to represent in miniature the marbled lung of lung plague. Sometimes the lesion is superficial so that the entire diseased mass can be scraped off with little or no loss of blood, while in other cases it extends down through the cutis into the subcutaneous tissues. In one case at Ithaca the lateral cartilage was involved so that a considerable portion had to be excised.

Lesions. The lesions vary according to the season. In the winter the dormant process leaves the affected tissue, in the main fibrous, with only narrow spaces filled with a caseous or calcic debris. In summer, on the contrary, under the active inflammation, the fibroid material is largely attenuated and replaced by cells, embryonic and fibro-plastic, and the alveolar spaces are enlarged and filled with a greater amount of caseous matter. In proceeding from without inward there is first the wall of organized fibrous tissue infiltrated by the abundance of cell organisms; then there is a zone of transition tissue partly fibro-cellular and partly caseated; finally there is the mass of caseated contents filling the alveolus and in the midst of this is the minute worm rolled upon itself. The caseated nucleus may be more or less calcified and the cretifaction may invade the fibrous walls of the alveoli as well.

Prevention. This may be attempted along the lines adopted for other worms, the avoidance of water and fodder that have been exposed to contamination, the boiling or salting of suspected specimens, the use of water from deep, closed, cemented wells only, and the constant access of the animal to salt are among the desirable precautions. When suspected food or water must be used, such agents as quassia or areca nut may be given.

Treatment. An important consideration is to restrain the animal from injuring himself by rubbing, biting, or scratching to relieve the intense pruritus. Beside mechanical restraint, we may resort to analgesics, the simplest of which is douching with cold water from a hose for 15 minutes at a time, and repeated several times a day. Carbolic acid (2:100); chloral hydrate; lead and opium lotion, or even cocaine may be applied. As local vermicides, various agents are recommended. A covering of iodoform on the scraped surface covered with a layer of collodion, and repeated daily has brought about a recovery in 15 days. Ether, chloroform or tincture of iodine applied on cotton wool for two minutes, and followed by collodion has done equally well. Ray applied arsenic sulphide in an imperceptible layer over the sore, which removed puritus and dried the wound into a scab, which became detached in 8 days, leaving a healing surface. A cool stall is in every case an important adjunct.

OTHER FORMS OF DERMATITIS FROM LARVÆ OF NEMATODES.

In various acute outbreaks of skin disease in the horse, nematode larvæ have been detected as a concurrent and evidently causative condition. Though we are left in some uncertainty as to the identity of the larvæ in any given case, they serve to show the tendency of young worms to invade the solid tissues, and to determine lesions in the integument.

Pflug records the case of a horse with thick crusts around the root of the tail, associated with intense itching, and under the crusts he found numerous embryo or larval worms, which he believed to be the young of the **oxyuris curvula**, that were present in large numbers in the colon and rectum.

Baruchello found in a cavalry regiment a large number of horses affected with inflammation along the line of the mane from the forelock to the withers, and on the rump, with the formation of tumors, in size from a millet seed to a pigeon's egg, isolated or confluent, and slightly tender but without pruritus. The nodules, at first hard, soon softened in the centre and, bursting, discharged pus containing numerous small, agamous nematodes, 2 to 5 mm. in length, thick toward the head with terminal, round mouth, and tapering to the tail which had the anus at its base. In other forms the tail was truncated and the anus terminal, but, placed in water, these developed into the first form. Three of the affected horses died and in the peritoneum were found a very large number of **Filaria Papillosa**, which the author plausibly concluded to be the parents of the larvæ in the skin. This outbreak agreed with those caused by *Filaria Irritans*, and the Indian *Bursatti*, in appearing in the warm season, spring and summer. It yielded to local treatment with sulphur, phenol, glycerine and vaseline.

HÆMATOZOA OF RUMINANTS.

Filaria in the pulmonary blood of camels. *Bilharzia crassa* in cattle and sheep. Sexes apart; length ½ to ⅔ inch; ovum fusiform. Habitat: Portal veins; Egypt, India, Italy; intestinal catarrh; pin-head swellings with ova in mucosa. Chylous urine (?). *Prevention:* As for distoma hepaticum. *Cysticercus Tenuicollis* in heart muscle. *Echinococcus* in heart, simple and multilocular.

NEMATODES. FILARIA have been found by Gonbaux and Evans respectively in the blood of camels. In both cases they occupied the pulmonary vessels, in one the mesenteric, and in one the lymphatic vessels as well. The failure to discover the **filaria cervina** in the ox is surprising, considering its frequency in the peritoneal cavity, in certain districts.

TREMATODES. **Schistosoma Bovis: Bilharzia Crassa: The Large Bilharzia.** This is a larger variety distinct from the Bilharzia hæmatobia of man, like which it has the sexes in different individuals. It was found by Sonsino at Zagazig, Egypt, in 1876, in the portal veins of sheep and cattle, and later at Calcutta and in Italy (75 per cent., Catania). The male is about ½ inch long, cylindrical and furnished with a groove on its ventral aspect in which the more slender female is held. The latter is about ⅔ inch long. Ovum is longer and narrower than in the S. hæmatobium of man, and has in addition a pyriform prolongation at one end. It encloses a ciliated embryo, which has a rudimentary digestive canal and swims freely in water.

Lesions: Symptoms. Intestinal catarrh, with round or papillary elevations on the mucosa the size of a pin head and enclosing the ova. Also exudation, thickening and ecchymoses of the intestinal and vesical mucosæ. Dilatation of the veins by the S. Bovis. Ova in manure or urine. It has been suggested that the hæmaturia in cattle and sheep in N. Africa is due to this parasite as is the chylous urine of man to the smaller variety.

Prevention. In view of the intermediary developmental changes of the trematodes in fresh water and molluscs, the rational course of prevention is in the line of that advised for *distoma hepaticum*. Filter, boil, or salt the drinking water, salt manure and urine. Burn infested carcases. Man is immune.

CESTODES: **Cysticercus Tenuicollis.** This has been found on the surface and in the muscular substance of the heart of ruminants, but no dangerous symptons have been the consequence.

Echinococcus Veterinorum. These have been found in the muscular substance of the heart and at different points of its substance, in the various countries of Europe. They have been mostly unilocular cysts, each containing its own proscolex. In some instances they were multilocular and many of them mere daughter cysts without heads. The cysts varied in size from a

pinhead to a turkey egg, and in some cases had become calcareous or caseated.

Distinctive *symptoms* during life have never been observed.

HÆMATOZOA OF RODENTS AND BIRDS.

Trypanosoma. This flagellate infusorium, already described as infesting the blood of the horse in *Surra*, has its counterpart in that of Guinea pigs, rabbits and hares. The mature parasite is about 30μ in length, cylindroid in front and median part, and tapering into a long, caudal flagellum. At the root of this appendix is a rounded corpuscle which colors deeply with reagents and is supposed to be the sucker. Birds harbor a similar organism. These may be found in strong, vigorous animals, but more commonly in thin, emaciated, weakly and anæmic subjects suffering from diarrhœa.

The fact that the flesh-fed dogs resist the bites of the *tsetse* (the bearer of the trypanosoma of sleeping sickness), while milk-fed dogs succumb (Laboulene) suggests the advantages of an exclusively flesh diet. The vegetable-feeding negro suffers more than the flesh-eating white man, yet the grain-eating pigeon resists, while the carnivorous rat, mouse, cat and weasel succumb.

HÆMATOZOA OF THE DOG.

Filaria Immitis: In heart and pulmonary arteries; 4 to 10 inches long; 6 labial papillæ; spiral tail in male; caudal bursa; ovoviviparous. *Distribution:* China, Japan, India, Brazil, Gulf States, Pennsylvania, Denmark, Italy, Germany, France. Lameness of Great Dane. Development: Mature in blood; embryos in superficial vessels at night, in thoracic and abdominal ones in day; are sucked by mosquitoes and lice, and has possibly an external habitat in water or aquatic host. Lesions: 5 to 500 in single host, around muscular pillars and cordæ tendinæ, in pulmonary artery, venæ cavæ, liver, subdermal connective tissue, embryos in nodes or exudates in pleura, spleen, kidneys, bladder; causes hæmorrhage, embolism. *Symptoms:* Impaired heart action, gastric catarrh; intestinal, cystic, pulmonary disorder, anæmia, fainting, paresis, deranged intellection; wasting and lameness of one hind limb; polyuria, albuminuria, tube casts, palpitations, cough; lung flat or crepitant. Embryos in blood drawn at night. *Treatment:* ol. terebinth, arsenic, strychnine, generous diet, out-door life; keep from unboiled water. *Filaria Recondita:* Embryos only, in puppies 5 to 6 months and upward; identity uncertain. No pathogenesis recorded.

Spiroptera Sanguinolenta: In cysts on aorta as on gullet, small shot, pea or walnut; abrasion of intima, orifice into aorta, clots, embolism, rupture into pleura, embolism of spinal vessels and paraplegia, rupture of aorta, fatal hæmorrhage. Prevention. *Strongylus Vasorum:* Causes endocarditis, endarteritis, embolisms. (See lung worms).

Filaria Immitis. This has been already referred to under pulmonary parasites. Its usual habitat is the right heart and pulmonary arterial system, where it is easily recognized *post-mortem* on account of its large size (4 to 10 inches long). Body white and thicker at the cephalic end. Mouth with six small papillæ. *Male* has the caudal extremity twisted in spiral, three or four turns, like a corkscrew, with two membranous wings, 22 papillæ in two lateral sets, and 2 spicula. Ovoviviparous.

Distribution. This worm was seen by Panthot in 1679. It has a very wide range of distribution but is particularly common in certain countries such as China, Japan, Hindoostan, Brazil and other tropical countries. In Europe they have been found most abundantly in Denmark, Italy, Germany and France. In North America they have been observed at Philadelphia and in Georgia and other Southern States. The lameness of the hind limbs in Great Danes has been referred to this parasite, and in China, European dogs die early on account of the parasite.

Development. The life history of the worm is imperfect. It attains sexual maturity in the blood, and there deposits its ova and embryos. Manson noted a habit of these embryos to abound in the superficial blood vessels during the night and retire to the large vessels of the chest and abdomen during the day, after the manner of the *filaria sanguinis hominis.* Neumann supposes that these embryos are sucked in by mosquitoes, fleas, or lice, on the death of which they escape into water, where they pass through a necessary intermediate stage of development, to be again taken in by the dog in drinking. This again agrees with the habit of the *filaria sanguinis hominis*, but for the *filaria immitis* absolute proof is still wanting. Most of the embryos taken in by fleas and lice perish in their intestine (Grassi). The *filaria immitis*, however, prevails especially in regions where the ground is low and wet and where there is every opportunity for an external existence of the worm in water or some aquatic host.

Lesions. The number of worms found in one patient may be

from five to several hundred (Megnin), and in exceptional cases all are of one sex. Usually there are two females to one male. They are found wound around the *columnæ carnæ* and *cordæ tendinæ* impeding the heart's movements, in the venæ cavæ anterior and posterior, and in the pulmonary artery and its ramifications in the lungs. Cardiac hypertrophy, and right cardiac engorgement are not uncommon, and pulmonary congestion has been noted especially on that side in which the parasites are found. Again the worms have been found in other organs, notably the liver (Leidy), the subcutaneous connective tissue (Ercolani, etc.) in which latter they are smaller than in the heart, yet sexually mature (Lanzilloti-Buonsanti). The same writer has found the embryos in subpleural nodules like millet-seeds or peas, and the coincident hæmorrhages and exudations found in other organs such as the spleen (Reuther), the kidneys and bladder (Leidy), the anterior and posterior cavæ (Schuppert, Labat) the pleura and pericardium, suggest their presence and the occurrence of coagulation, embolism, and congestion as a consequence. The filaria can pass through the placenta and appear in the unborn puppy.

Symptoms. These are exceedingly varied, according to the part attacked. The impaired heart action determines catarrhs of the stomach, bowels, urinary bladder or lungs, which may be further localized or aggravated by the presence of the worms or embryos in their blood vessels. It also leads to anæmia or irregular circulation in the brain, aggravated by embolism of the cerebral arteries with fainting, collapse, paresis, convulsions, and intellectual disturbance. Lameness of one hind limb with wasting of its muscles and even paralysis or paraplegia is not uncommon (especially in Great Danes) and may be due to obstruction of the vessels, to localization of groups of worms in the connective tissue, to impaired circulation in the spinal cord or even in the brain. The patient may become morose, or snappish so that the case may be mistaken for rabies. There may be polyuria, albuminuria, uriniferous casts, and epithelium, and the embryo is said to be passed in the urine, but absolute proof of this is lacking. Intermittent pulse and heart sounds, inequality of successive beats, palpitations and valvular murmurs are sometimes present. When the lungs are affected there are cough, dark red mucosæ,

flatness on percussion over limited areas, and crepitation or other modification of the respiratory murmur. Progressive emaciation and anæmia are common, with encreasing weakness.

An absolute *diagnosis* may sometimes be secured by drawing a little blood during the night and examining it microscopically for the embryos, 280μ in length and furnished with delicate pointed tails. The embryos are often found in enormous numbers in the blood of dogs that show symptoms of ill health.

Treatment of these cases has been attempted by giving oil of turpentine 30 drops, in pill, daily for a week, and again by Bordeaux turpentine ½ to 1 drachm, in pill, daily. I have obtained a steady improvement by giving daily 10 drops of a one per cent. solution of arsenite of soda in combination with nux. As in all parasitic diseases much depends on sustaining the general health, so that a rich diet of easy digestion may enable the animal to bear up until the worms have completed the term of their natural lives, when, if no more are taken in, a recovery may ensue. The patient must, of course, be denied access to all standing water in which the embryos of the worms may be found.

Hæmatozoön Lewisi. Filaria Recondita. The embryos of one or more nematoids have been found in large numbers in the blood of the dog by Gruby and Delafond, Lewis, Manson, Sonsino, Grassi and others. The **hæmatozoön Lewisi** is 280μ long, with a thin, delicate tail, and a round mouth which expands, acting like a sucker when the worm fixes itself by this to the cover glass. In France they were found in 4 to 5 per cent. of the dogs examined (Gruby), while in China, Calcutta and Italy they were found in 33 per cent. (Manson, Lewis, Sonsino). The numbers in a single host are varied but usually enormous, from 3 to 15 in a single drop of blood, or from 11,000 to 1,000,000 in the patient (Gruby and Delafond, Rieck). They have been supposed to pass from dam to fœtus, but Gruby and Delafond could not detect them in the blood until the puppy was 5 to 6 months old. When injected directly into the veins of sound dogs they disappeared in 8 to 40 days, in two cases, however, they persisted for three years and then the adult worm was not found at the necropsy. It may be questioned whether the dogs had not taken in fresh worms in the course of this time.

The mature form of this worm is unknown. Van Siebold looked

on the embryos as migrating nematodes and not necessarily all of one species. Yet their form and habit of attaching themselves by the mouth to a cover glass seems to closely differentiate them from others. Embryo nematodes found in the digestive cavity of the dog flea, the cat flea, the dog louse (hæmatopinus piliferus), and in a particular tick (rhipicephalus siculus) have been taken by different observers for the *hæmatozoön Lewisi*; but these did not correspond either as regards the particular canine host, the locality where they prevail, or the morphology of the embryo. Grassi and Calandruccio supposed that they had found the mature worm in a non-fecundated female, 1 inch in length, in the fatty tissue around the kidney of a dog. There is, however, no real proof of the identity.

Symptoms. As a rule the presence of these embryos appears to be harmless. Yet Gruby and Delafond have seen coincident epileptic seizures.

Treatment and *Prevention* may be tried along the same lines advised for filaria immitis.

Spiroptera Sanguinolenta. This worm is most commonly found in cysts on the gullet of the dog, yet it has been not unfrequently found in similar tumors on the aorta and renal artery. The anterior aorta is their usual seat and the tumors vary in size from a small shot to a pea, hazelnut, or even a walnut. They existed in groups or simply at intervals, and extended through the aortic walls projecting externally and showing a bloody spot or extravasation on the inner coat. The intima might be abraded or the seat of an exudate or coagulum. The smaller nodules contain the embryos, while in the large the sexually mature worms may be found. Part of the worm may protrude into the vessel among the flowing blood. They are rare in the posterior aorta, yet they have been found in the vicinity of the renal arteries by Morgagni and Megnin, respectively. The embryos are believed to undergo evolution in the circulating blood, but the full life history of the parasite remains unknown.

Symptoms. Lewis has seen the lumen of the aorta all but blocked by a clot determined by the worm. Manson asserts that the rupture of the cyst may bring on a fatal pleurisy. He further claims that entering the circulation the embryos cause clots

and emboli of the spinal cord with consequent paraplegia. Again dogs die suddenly from rapidly induced anæmia caused by rupture of the aortic walls which have become softened and atheromatous around the verminous nodules (Megnin, Chauvrat, Perroncito, Caparini).

Treatment. So long as the life history of the worm is imperfect, prevention and treatment can only be attempted along general lines as advised for filaria immitis.

Strongylus Vasorum. Already referred to under lung worms of the dog; this, as its name implies, is essentially a parasite of the blood and blood vessels. The result is endocarditis, and endarteritis, with the formation of clots and embolisms, yet in many cases the presence of the worms has not given rise to appreciable symptoms. (See under *Lung worms of Dogs*).

HÆMATOZOA OF BIRDS.

Protozoa: Like plasmodium malariæ in red globules. Birds nearly immune from their ill-effects. *Trypanosoma sanguinis avium:* Shows no pathogenesis on birds. *Nematodes*: Filaria round heart of duck, others in connective tissue and in blood

Protozoa. In the blood of birds in malarial districts have been found protozoa resembling in form and transitions the plasmodium malariæ of man. These have been found as hyaline bodies (pigmented or not), sporulating forms, crescentic forms, and flagellated bodies. They live in the red blood cells from which they produce black pigment, and are most abundant in the warm season, from spring to autumn. Danilewsky held them to be identical with the plasmodium of ague, but they differ somewhat in morphology, the hyaline bodies show little or no amœboid movement, they rarely produce febrile reaction in the bird, neither their development nor persistence in the blood is affected by quinine, and inoculated in the blood of man, they do not cause infection nor malarial symptoms. Inoculation of the blood of a malarial person on birds is equally without effect (Di Mattei). Though sometimes associated with low condition and general ill health in the bird their rôle as a causative factor has not been fully demonstrated. They seem to be closely allied to the para-

site of man, and birds show a measure of immunity from their ill effects, either as a racial or acquired characteristic.

Trypanosma sanguinis avium. This has been found by Danilewsky in the blood of birds. It closely resembles the trypanosma of *surra*, but has shown no constant pathogenic action on birds.

Nematodes. Rudolphi found a filaria wound around the heart of a duck. Mazzanti found subcutem, in the neck of a pigeon, a female filaria ⅔ inch long, and in the blood of the same animal many embryos 185μ long with sharp tails and smaller specimens with blunt tails.

PARASITES OF MUSCULAR AND CONNECTIVE TISSUE.

TRICHINOSIS: TRICHINIASIS.

Definition. Intestinal and muscular. Hosts: Man, pig, rat, mouse, dog, cat, horse, Guinea-pig, rabbit, goose; among animals about habitations, together with many wild creatures. Not in invertebrate or cold-blooded. Anguillula, ollulanus, and many embryo worms often mistaken for this. *Trichina Spiralis*: 1.4 to 4 mm. long; anterior half tapers to head; mouth and anus terminal; digestive tract in three divisions, anterior triangular, median with nucleated cells, and posterior narrow and muscular; viviparous; embryo 90 to 100μ long. *Larva*—muscle trichina—1 mm. long, free or encysted in muscle fasiculi, intermuscular connective tissue, adipose tissue, or intestinal walls. History. Geographical distribution: Europe, North and South America, China, India, Syria, Algiers, etc. *Life history:* Sexual maturity only reached in intestines of suitable warm-blooded animals, though passes alive through the body of fish; expelled in fæces, mature worm perishes in water, embryos live; ovigerous female found in gland ducts of intestinal mucosa, mesentery and mesenteric glands. Embryo migrates in blood but mainly in lymph vessels. Larvæ set free in stomach from trichinous meat in 5 to 20 hours, becomes mature in 1 to 3 days more; larva found in diaphragm seventh day, in muscles generally the thirteenth; also in serosæ. One female has 15,000 ova. Curling in figure 8, or spiral becomes covered by fibro-cellular cyst 0.4 mm. long. Host being eaten the freed larvæ repeat the above for new generation; or host living they finally die and cyst is calcified. *Successive hosts in chain:* Pig and rodent, rat, mouse; dog and hog about abattoirs; man and pig; rat, pig and man. Infested chopping block, sausage cases, under-done pork. Trichinosis in different countries. *Symptoms: Intestinal* for 15 days, colic, tenderness, anorexia, nausea, diarrhœa, weariness. *Muscular* tenth to fortieth day, muscles swollen, tender, stiff, cramps, unlike rheumatism, spares joints and tendon sheaths, œdema,

stertor, skin eruption, hyperthermia, albuminuria. In swine. usually pass unnoticed. *Diagnosis:* **Trichina harpoon, antiseptic incision, Duchenne's punch.** *Treatment:* **First by emesis; stomach-pump or tube; wash stomach with glycerine; whisky, alcohol, vermifuge, purgative.** ***Prevention in Swine:*** **Do not give uncooked meat, unboiled water, kill vermin, boil swill; avoid drainage from other herds, abattoirs, rendering works, sewers, privies; prevent swine running at large where they can get human excrement; burn, etc., all infested carcases, hogs, mice, rats, etc.** ***Prevention in Man:*** **Eradicate from swine; thoroughly cook all flesh; freeze throughout to 14° C.; salt thoroughly for one month; examine microscopically all pork; technic of examination; organisms mistaken for trichinæ. Classification of trichinous pork.**

Definition. The invasion of a living organism, and especially the alimentary canal and the voluntary muscles by the trichina spiralis.

Stages. Forms. The trichina attacking any host, invades *first* the alimentary canal—**intestinal trichinosis**—in which the sexually mature trichinæ live in the intestines and propagate their kind—and *second* it enters the intestinal walls, striated muscles and other solid tissues in which the larvæ encyst themselves and remain enclosed without further development—**muscular trichinosis.** These two forms are in a sense one continuous invasion, the mature trichinæ in the intestine perishing after they have given birth to their young, and the young or larvæ boring their way into the muscular tissues to remain there but partially developed and asexual.

Animals Susceptible. The known hosts of trichina spiralis are man, pig, brown rat, mouse, dog, and less frequently badger, cat, polecat, fox, horse, ape, Guineapig, rabbit, coon, marten, bear, hamster, hippopotamus, mole, hedgehog, crow and goose. Many other animals may be infested by experimental feeding of trichinous flesh and are therefore possible hosts. On the other hand they have never been found in invertebrate nor cold-blooded animals, and many alleged cases of trichinosis in mammals and birds have been shown to be due to embryos of worms of entirely different species. The anguillula found in decaying beets and turnips (Schacht), and in the intestines of animals eating them raw, is quite distinct, and does not invade the muscles. The vinegar eel (anguillula aceti) has been mistaken for trichina. A flesh worm found in the mole (Vogel, Herbst) could not be made to

infest pigs (Virchow, Fiedler), and is really an ascaris embryo (Leuckart). Nematodes found in earth worms were rhabditis or spiroptera larvæ (Leuckart). Flesh worms in the large water newt (triton cristatus) were anguillulæ. Worms found in the muscular tissues of hens, owls and other birds, and of eels, have proved not to be trichinæ. In cats, rats and mice the larvæ of the ollulanus tricuspis, encysted in the diaphragm, liver or lungs, have often been mistaken for trichinæ.

It should be added that though an animal is unfitted to be a host of the trichina in its larval encysted stage, it does not follow that it cannot be transferred through the body of that host. Thus Colin fed fish and reptiles with trichinous meat and produced trichinosis in other animals by feeding them on the fæces of the animals first named. (Compt. Rend. lxvi, p. 31).

Trichina Spiralis : Trichinella Spiralis. This is the single authenticated species of the *Genus :* **Trichina** (trix hair).

The Sexually Mature Trichinæ inhabit the intestines, large and small, and if expelled in the liquid fæces soon perish. They are scarcely visible to the naked eye, the *male* being 1.4 to 1.6 mm. long, 40μ broad ; the *female* 3 to 4 mm. long and 60μ broad. The anterior half of the body gradually tapers to the head, while the posterior half retains about the same thickness throughout. Mouth and anus are both terminal, the former being small, round and smooth. The anus in the male is flanked on the two sides by two papillary, copulatory projections, and the everted cloaca serves as a penis. In the female the vulva opens about the limit of the anterior fourth of the body. The alimentary canal is divided into three parts : the anterior (œsophagean) triangular on transverse section ; the median, covered with nucleated cells which give a peculiar beaded appearance, is the small intestine ; and the posterior, narrow and muscular, is the rectum.

The trichina is *viviparous*, the fecundated ova hatching out in the body of the uterus, and the escaping embryos making their way into the vagina, to pass out by the vulva. The *embryo* is 90 to 100μ long, by 6μ in its median and thickest part.

The **larval** or **muscle trichina** is about 1 mm. long by 40μ broad, narrowed toward the cephalic end, furnished with an alimentary canal in three parts as in the mature, but with a simple tube only representing the undeveloped sexual organs. These

are found at first free, and later in lozenge-shaped cysts, among the muscular fasiculi, in the intermuscular connective tissue and more rarely in the adipose tissues or intestinal walls.

History. Calcified trichina cysts were noticed by Peacock in 1828, and the muscle preserved in Guy's Hospital, London. Hilton recorded similar appearances in the muscles of a man of 70, in 1832. Tiedemann had found minute calcified capsules in a gouty subject as early as 1821 bnt the description makes them too large, and unless there was a mistake in measurement they cannot be accepted as genuine. For the first time in 1834, Paget saw and described the worm rolled up in its capsule, and a year later Richard Owen described and named the parasite. Herbst (1850) developed muscle trichinosis in animals by feeding trichinous flesh. Virchow and Leuckart (1859) fed trichinous flesh to dog and pig respectively and claimed to have found the mature trichinæ in the bowels, but to Zenker belongs the credit of tracing the cycle of life of the worm and its pathogenic action on its host. He traced an attack of trichinosis in a woman to the trichinous pork she had eaten, and feeding the infested pork to various mammals, produced trichinosis in each. He demonstrated the young worms in migration, and that they caused a deadly disease in man.

Geographical Distribution. Trichinæ have been found in every country in which they have been sought for. They appear to be more prevalent in particular countries and districts, as in Germany and the western states of America, but this impression comes largely from the more careful pork inspection in these countries, and when real may be traced to the conditions under which the hogs are raised. The idea that the trichina was absent from Europe until the 19th century, is untenable. It was demonstrated there as elsewhere when the microscope was brought to bear on the muscle of man and pig. One hypothesis is that the brown rat (mus decumanus) brought the parasite with him when he migrated from Asia, and another that it was introduced in the Chines pig which was imported into England in the third decade of the 19th century and into Germany on the fourth (Gerlach). But Peacock's specimen in Guy's Hospital, already old and calcified when found, dates back to 1828, and Tiedemann's to 1821. Trichinous pigs have been found in Europe, North and South America, China, Hindoostan, Syria, Algiers, and elsewhere.

Life History. Successive Habitats: Migrations. The trichina only reaches *sexual maturity* in the intestines of a suitable host. It may pass through the intestine of an unsuitable host, like a fish or reptile, without losing vitality (Colin), and the same appears to be true of certain birds the muscles of which do not become infested. Expelled from the bowels in the liquid fæces the mature worms soon perish, while the embryos may live for an indefinite period in water, and communicate trichinosis to susceptible animals which drink it. The ovigerous female is often found in the intestinal follicles, in the agminated and solitary glands (Pagenstecher) and even in the mesentery and mesenteric glands (Cerfontaine, Askanazy) in which accordingly the young can be brought forth.

The *embryos* whether produced in the intestines, gland follicles, mesentery or lymph glands, or introduced in drinking water are the real migratory trichinæ. They have been found to a very limited extent in the blood, in which they can be carried to the most distant parts of the body, but they appear to advance mainly along the lymph spaces in the connective tissue and lymph vessels. This explains their relatively greater numbers, both early and late, in the diaphragm, lumbar and abdominal muscles.

When trichinous flesh is introduced into the stomach it is digested and the trichinæ set free in five to twenty hours, the greater number at the earlier period. The larva once freed from its cyst, attains sexual maturity in one, two or three days more, and fully ripened embryos are found in the womb of some of the females in four days after ingestion of the meat (Colberg, Hun, Neumann). They may be found in the diaphragm by the seventh day, and in the muscles generally by the thirteenth (Pagenstecher). Many are early found in the peritoneal and other serous cavities.

The number of young produced by a single female is estimated by Neumann at 10,000 to 15,000, in a series of births of 1,200 at a time and extending over six weeks. Live prolific trichinæ have been found, very exceptionally, in the intestines after 12 weeks (Kroatz and Cohnheim). This serves to explain the millions of muscle trichinæ which come from the ingestion of a very small amount of trichinous flesh.

On reaching the muscular or other tissue in which they are to be encysted, the young worms are at first seen free in the connec-

tive tissue spaces, straight or perhaps slightly sinuons. Soon they curl into a figure of 8, and later usually assume a spiral form. In the interfascicular connective tissue the trichina causes irritatation, inflammation, exudation, cell-proliferation, and finally organization into a homogeneous transparent ovoid cyst, with more or less granular matter. Most commonly the trichina penetrates the sarcolemma and develops within it, displacing and causing absorption of the primitive muscular fibres. The cyst is about 0.4 mm long, by 0.25 mm. broad, the prolongation at the poles varying so that it has sometimes a fusiform and sometimes a pyriform outline. If treated with picrocarmine the cyst absorbs mainly the picric acid and stands out yellow amid the surrounding rosy-red of the muscle. If injected the cyst is seen to be enveloped in a close capillary network.

Trichina cysts are also found in the adipose tissue and in the intestinal walls.

Once encysted the larval worm is incapable of further development, until its host is eaten by an animal in which it can develop. If this is long delayed the worm perishes, the nutrition of the cyst ceases, and it undergoes fatty or calcic degeneration. In the latter case the muscle in the cadaver appears marked by numerous minute white spots as if it had been sprinkled with flour. The calcareous matter (carbonate and phosphate of lime) can be dissolved out by acids, but no distinct trace of the worm remains.

If the infested muscle with the trichina cysts, recent and undegenerated, is eaten by a suitable host, the muscle and cysts are digested and the worms set free, to reach maturity and reproduce their kind as already described.

Causes. These are mainly conditions that favor the reception of the encysted trichina by a host which can advance it to maturity, and which can entertain the offspring in its own muscles in turn. Certain chains play a most important part in this development.

The chain constituted by the pig on the one hand and the rat (brown or black), mouse and other small rodents on the other, is one of the most fundamental. This is especially noticed about slaughter-houses or other places where the products of dead pigs are handled. The rats and mice eating trichinous pork become sick, stiff, lame and are easily caught and eaten by the hogs that

are kept to eat up the waste. Thus new hogs are infested and the trouble moves around its vicious circle tending to a constantly encreasing prevalence.

In the same way hog is infected by hog, when a herd is kept at or near a slaughter-house to eat up the offal.

Another cycle may be found through the manure of the infested, containing the embryos. The dejections of infested rats and mice are taken in with the food, and the dejections of the infested pigs are carried into their troughs by the snouts and feet, or washed into pools, wells or streams from which they are supplied.

At Bamberg abattoir 50 per cent of the rats were trichinous, and at Boston slaughter-houses 76 per cent. In stables apart from abattoirs the ratio was from 7 to 10 per cent. only. In country districts 2 to 3 per cent. is a high average for America and great areas are entirely free from it.

It must be recognized that rats will eat their own dead, so that here we meet another line of propagation.

Man usually derives trichinæ from pork, but here the cycle usually ends as the hog cannot obtain human flesh. Yet in many localities where hogs run at large and have access to human defecations and to the water that has received drainage from these, the pig still secures a contingent of trichina from man.

Man may further be infested by meats, otherwise sound, which have been laid or cut on the same chopping block, counter or scales, by bread which has been cut by a knife which has just been used for cutting raw pork, by contamination through kitchen table or refrigerator, or by water which has received drainage from dejections of affected men or animals.

An unsuspected source of the parasite is found in infested sausage cases. The contents of the sausage may have been thoroughly examined and proved, but the presence of trichina, as wandering embryos or encysted larvæ, in the intestinal walls will render the sausage infesting. As many persons eat sausage raw or nearly so the danger from this socurce is a very real one.

Trichinosis in man is much more common in Germany than in America, chiefly on account of the German habit of eating raw or underdone sausages and pork. The infrequent victims in America are very often members of German families. The

American who persistently declines *rare* meat, especially pork, escapes.

Statistics seem to show that, in spite of the density of the population which is favorable to propagation, the percentage of trichinous pigs in Europe, is lower than in America. The following ratios are given by Neumann: In Holland, Sweden, Denmark and Russia 12:1000; in Prussia 0.54:1000; in Posen 5.18:1000; in Shroda 14.75:1000; in Germany as a whole 0.1 to 0.13:1000. It is largely concentrated in given localities, but the statistics are also largely affected by the relative care in microscopic examination in different places.

Symptoms. In all animals trichinosis is manifested by two stages, corresponding to the successive habitats of the worms, in the *intestines*, and in the *muscular and other tissues*, respectively. The first stage corresponds to the *first* ten to fifteen days after the ingestion of the trichinous flesh, and the *second* to the tenth or fifteenth day on to the fortieth. The symptoms are usually more violent in man than in the pig, though this does not apply to many of the smaller animals infected experimentally.

Symptoms in Man. The **intestinal** symptoms begin on the second or third day after the ingestion of the trichinous flesh, or as soon as the worms set free by the digestion of their capsules have undergone material development and attained sexual maturity. There are general abdominal tenderness, colicy pains, inappetence, nausea, vomiting and diarrhœa, sometimes mixed with blood. In some instances this is followed by an obstinate constipation, probably owing to the inflammation of the intestinal walls. Collapse and death may follow at this early stage.

About this time, and often before the migration into the muscles, there is usually a sense of great weariness and muscular fatigue, with alternate chills and flashes of heat, perspiration and thirst. Friedreich suggests that this is due to a poison elaborated by the worm and set free by the removal of its capsule.

These early symptoms have often been mistaken for those of typhoid fever, which is the more probable if red spots appear on the skin. The number of victims, the history of the case, and above all the presence of trichinæ in the stools should correct this mistake.

The **migration** or **muscular** symptoms are noted from the

tenth to the fortieth day, and have been often mistaken for rheumatism. A rigidity of the abdominal muscles may be felt as early as the eighth day, but that of the jaws, back and limbs beginning about the thirteenth day is much more diagnostic. The muscles are swollen, tender to movement or pressure, stiff, or rigid even to a wooden hardness. There may be persistent tonic contraction which clinches the jaws, holds the limbs rigidly semi-flexed, or renders the breathing short and catching. The condition is to be distinguished from rheumatism, by the fact that the joints and tendinous sheaths escape, as well as by the history, the consumption of raw pork, the early bowel symptoms, and the numbers attacked.

Œdema is a very common symptom beginning with the eyelids, and affecting the face, extremities, scrotum, prepuce and other parts. It may be slight or excessive, appearing as soon as the seventh day and remitting on the twelfth to reappear later. It may lead to chemosis, and may be attended by choked disc, or exophthalmos. Bleeding may occur from the nose, prepuce or vulva.

Hoarseness, and dyspnœa are not uncommon in connection with invasion of the laryngeal muscles, œdema glottidis, or bronchial catarrh. Hypostatic pneumonia is occasionally seen.

Skin eruptions, acne, boils or urticaria are frequent, and also hyperæsthesia, or itching as a sequel of the dropsy.

The temperature usually rises (104° to 106°) but it may be normal or subnormal. It is highest at night and the elevation may last from four to seven weeks.

Urine may be albuminous, and may be tinged by red blood globules, or contain hyaline casts.

Insomnia and headache attend on severe cases, and death may be preceded by delirium, coma or collapse.

Death may occur in the first few days, or from exhaustion or some complication up to the sixth, or exceptionally, the eighth week. After the sixth week most cases recover, undergoing a slow convalesence.

Among sequelæ may be noted ; persistent muscular weakness, stiffness or pain, a tendency to obesity, or loss of hair.

During the progress of trichinosis a marked leukocytosis occurs especially of the eosinophile cells.

Symptoms in Swine. When the invasion is slight, as is usually the case, no symptoms are observed. The hog appears to be less sensitive than man to the intestinal and muscular irritation caused by the trichina, and no less so to the Friedreich toxin which proves so depressing to the human subject. The majority of trichinous invasions of swine pass unnoticed.

The symptoms caused by a large amount of trichinous flesh, are divided into intestinal and muscular as in the human victims.

Intestinal. In Gerlach's experimental cases the *milder forms* showed only some slight impairment of appetite, and of vivacity, dropping of the tail and tendency to remain recumbent in the litter. This may set in in three days and continue for a couple of weeks, and is followed by recovery. In more *severe cases* signs of illness appear in three to ten days, such as greatly impaired or complete loss of appetite, sometimes vomiting, dullness, drooping tail, constant decubitus, with the hind limbs extended, pawing or shifting of the feet when the pig is raised, stiff, hesitating movements of the hind limbs, arching of the back, tucking up of the abdomen, which is tender to manipulation, diarrhœa, hyperthermia with exacerbation at night, marked thirst, grinding of the teeth, pendent head, swollen conjunctiva, glassy eyes, coldness of the skin, erection of the bristles and general weakness. Death may take place during this stage, but usually in young pigs only, or old animals in low condition and debility.

Intestinal symptoms may last one or several weeks in different cases.

Muscular. From the eighth to the fifteenth day or even later, the muscular symptoms appear. There may be an improvement of appetite, or subsidence of diarrhœa, or on the other hand an appearance of hyperthermia for the first time. The pig is more restless than before, lying down most of the time yet often rising and changing position, the body but especially the hind limbs are stiff, rigid and it may be hard to the touch, and the movements are hesitating, dragging and uncertain with an appearance of paraplegia. The abdomen may be less tender, but the muscles become distinctly so to the touch, and there may be pruritus especially if the panniculus is infested (Röll). The voice may become hoarse or husky, mastication and deglutition are difficult, the jaws may be fixed (trismus) and even the movements of the

lips and tongue may be impaired. The pig plunges its snout deeply in its liquid food and takes it with effort, and in small amount only. Breathing is often hurried and panting. Fæces may be passed involuntarily. Redness of the eyes, often present at first, tends to disappear, and œdema of the lids is rarely present, but there may be some infiltration and thickening of the cheeks, lips, throat, shoulders, fore limbs and sheath. This is usually seen in the worse cases only, associated with much weakness, and presages an early death.

In the great majority of cases recovery takes place, but convalescence is liable to be slow, and the pig remains weak in its muscles, unsteady in its motions and somewhat paretic owing to the extensive destruction of the muscular tissue. This does not, however, as a rule, interfere with fattening, which seems even to be favored in certain cases, by the lazy, inactive habits of the animal, associated as they are with good appetite and digestion.

Diagnosis is difficult, and the disease is largely confounded with indigestion, diarrhœa, hog cholera, gastro-intestinal poisons, rheumatism, stephanurus dentatus, and nervous affections. It is to be identified mainly by the history showing that the swine have access to rats, mice, raw pork, or the washings of the same, the fæces of man or hog, or the drainage from the same, that a number have been attacked at once without any special exposure, poisons in food or other appreciable cause, that there have been the earlier intestinal symptoms with diarrhœa, followed by the secondary muscular symptoms, that the rheumatoid symptoms are confined to the muscles, while the joints are respected, and that trichina can be found (though often with difficulty) in the liquid fæces. The final test is by microscopic examination of the muscles in the second stage of the disease. This is done by **harpooning** or by **antiseptic incision** and removal of a small portion of muscle. The simplest *trichina harpoon* is made like a fish-hook, the reversed barbs of which are double. This is pushed into the middle of the affected muscle and in being pulled out draws with it a small portion of the muscular tissue which is then put under the microscope. The punch of Duchenne is a fine trochar and cannula about 2 mm. in diameter, and presenting near the point of the canula a notch, the distal border of which is sharp and cutting; the trochar has a similar notch which cor-

responds to that of the cannula when slightly withdrawn. The trochar is driven home before it is inserted into the suspected muscle, it is then drawn out about ⅓ inch, and the instrument being withdrawn it is found to enclose a particle of the muscular tissue. In making a selection in slight cases or in the early stages of the disease a preference should be given to the abdominal and posterior intercostal muscles, and in every case to the extremities of the muscular fibers, close to their insertion on tendon or fascia. Owing to the excess of fat the pig is a less satisfactory subject for harpooning than the human being. In removal of a portion of muscle by incision, the skin may be cleaned by a soapy wash, wet with an antiseptic, and injected with a 4 per cent. solution of cocaine. In ten minutes, incision may be made, a small portion of muscle cut out close to the tendon and the wound closed by suture. (For microscopic examination see below).

Treatmeut. This is of value while the trichinæ are confined to the intestines, and the earlier it is adopted the more hopeful is the attempt to **abort the attack.** If the patient is seen just after the ingestion of the trichinous flesh and before it has left the stomach, active **vomiting** by ½ to 1 grain tartar emetic with tepid water and tickling of the fauces with a feather may succeed in expelling the greater part of the offensive ingesta. Or apomorphia may be employed instead. If seen later, after digestion has been effected, the **stomach pump** or tube (syphon) may be employed to wash out the finely disintegrated and liquid contents. In this case the liquid used to wash out the stomach may contain one or two ounces of **glycerine** as a non-poisonous trichinicide.

The bowels should be cleared by a full dose of **castor oil** or **calomel**, and a dose of glycerine as above will be a useful addition. The purgative may be repeated daily for some days, and copious **injections with glycerine** or even **salt** should be thrown into the colon. In this way the bowels may be cleared of the greater part of the parasites and the disease aborted or rendered mild and often harmless. Other vermifuges may be tried but none is so effective and harmless as glycerine. **Alcohol** in concentrated solution (whisky, brandy) has been recommended, but it is useless in dilute solution and such a volatile agent is so rapidly absorbed, that it is only in the stomach that the degree of

concentration can be confidently secured. The stomach can be more promptly cleared by emetics. Its value is, therefore, mainly as an adjunct to emetics in the earliest stages. Mosler, who introduced benzine (1 dr. twice daily), abandoned it on the same account. It may, however, be made an adjunct of emetics.

In every case, of course, the patient must be protected from any further access of trichinæ through food or water.

When the muscular symptoms have appeared nothing can be done to destroy the wandering embryos, yet the remaining swarm in the bowels may still be expelled so as to restrict the migration as far as possible. The muscular pains may be calmed by **morphine, phenacetin** or **chloral hydrate** with warm baths. The patient should have nourishing and easily digested food to maintain the strength.

Prevention in Swine. As pork is almost the only channel through which trichinæ invade the human system, the absolute extinction of trichina in the pig would virtually put an end to outbreaks of trichinosis in man. The main precautions may be enumerated in order:

1. **No pig feeding should be allowed in connection with slaughter-houses or rendering works.** The feeding of swine on the raw offal or scraps of animals (and especially hogs) slaughtered must sooner or later lead to an epizoötic of trichinosis in the herd. Even if extraordinary precautions are taken to boil thoroughly all waste products of the abattoir before they are given to the pigs, this will not prevent the rats, mice and other vermin from preying on the fresh scraps and meat, infesting themselves, and conveying the trichinæ indirectly to the hog pen.

2. **Rats, mice and other vermin should be carefully exterminated from other piggeries.** After the pig these are the most frequent hosts of the trichina, which they get from kitchen meats, scraps and swill, from the excreta and flesh of each other, and from other sources, so that if trichinosis exists in the neighborhood they become infested and infest the pigs in their turn.

3. When hogs are fed on the offal of abattoirs, it should be at a distance from the latter and the **slaughter-house products should have been subjected to prolonged boiling** and carried to the hog pens in vessels which have also been just subjected to a boiling temperature.

4. **Kitchen scraps and swill should also be thoroughly boiled before moving them to the pig pen.** If taken to the pen raw there will be many loopholes for diffusion of trichinæ and especially through rats and other vermin, in which the worms rapidly multiply. If the meats are first cut into pieces of three inches in diameter, the boiling may be implicitly relied on.

5. **Hog pens, yards or pastures should not be allowed on streams** (especially small or sluggish ones) that have received the drainage of ground or pens occupied by other hogs, of slaughter-houses, rendering works, sewers or privies.

6. **Hogs must be prevented from running at large** on unfenced grounds, highways, commons, or any place where they can find human excrement.

7. All **carcases of hogs,** not destined for human food **should be promptly burned, dissolved in acids or subjected to prolonged boiling** (better if superheated as in rendering). **Dead rats, mice** and other vermin should be similarly treated.

Prevention in Man. The foundation of radical prevention of trichinosis in man rests on the extermination of the worm in the pig. Until that can be done other measures of protection must be maintained for the human race.

1. **Thoroughly cook all flesh that is to be eaten.** It has been shown that epidemics of trichinosis occur chiefly in persons who eat pork underdone, and hence the frequency of such outbreaks in Northern Germany and in German families in America and their rarity in Belgium, France, England and America. The thoroughness of the cooking is the main question and the experiments of Colin especially throw definite light on this question. A mass of trichinous flesh weighing four pounds subjected to active boiling for an hour and a half and then fed to a dog and a brown rat produced no living trichina in their intestine. A second piece weighing eight pounds was only sterilized in the centre at the end of four hours of continuous boiling. The best rough test is whether the interior of the cooked piece of meat has had its center completely coagulated and rendered of a pale brownish color. If not, and if the red blood still oozes from its cut surface the temperature has been insufficient to kill trichinæ. Again pork that is hurriedly roasted will usually show the red blood oozing from the centre when cut, and the heat has not risen to

the killing point (140°F.). The time of exposure, the intensity of the heat, and the suddenness of the cooling all affect the result. The roast that is kept in a warm atmosphere for some time after removal from the fire continues to transmit the heat of its outer layers to the interior, which manifestly cannot happen when it is suddenly chilled. Sausages are especially dangerous as many eat them after a slight frizzling of the surface, which in no sense affects the interior.

Other conditions affect the trichinæ, reducing their vitality and rendering them more susceptible to the action of heat. Three days exposure to the open air at—20° to—25°C. (—3° to—13°F) failed to kill trichinæ (Leuckart), yet Fiedler says they die when actually exposed to—14° C. (+ 7° F.) and Kühn found that they had perished after two mouths in an ice-house, though at a higher temperature.

In this connection it is interesting to note that the trichinæ survive one hundred days in putrefying meat, showing that mere lapse of time is unimportant.

The thorough **salting** of the pork slowly kills the trichinæ. A light salting is ineffective, but the thorough penetration of the salt in quantity to all parts of the ham or bacon, destroys the trichinæ in the course of a month, or two months in the case of the largest hams. Thus it is that in spite of all the complaint in Germany of the trichinæ in America, a standing reward has been offered for years past for a single case of trichinosis that can be indubitably traced to the eating of American ham or bacon, yet no case of the kind has been adduced. Many outbreaks of trichinosis have been recorded in Germany during this period but all have been traced to the consumption of home-grown pork. Direct experiments on small animals with salted American pork have been made at Paris, Lyons, Rouen, Thionville, Strassburg, Munich, Antwerp, Utrecht, Rotterdam, Basle, and in Italy, and have failed to convey trichinosis (Neumann). Colin found that in large hams it sometimes took two months to destroy the trichinæ in the deepest layers, though those in the superficial parts had been promptly killed. In sausage, in which the salt was thoroughly diffused at the beginning, he found that a slight pickling destroyed the trichinæ in fifteen days. At Emersleben the trichinous pork, minced and salted, killed 33 per cent. of the persons

that ate it after 24 hours, but proved harmless to those that ate it six days later.

Hot Smoking at 60° to 65° C. (140° to 149° F.) for twenty-four hours, kills the trichina, while cold smoking only attained the same end after three days' continuous exposure to the smoke. (Küchenmeister, Haubner, Leisering).

The destructiveness of these methods is undoubted, yet everything depends on the degree, and if it were once decided to admit to consumption trichinous pork which had been thoroughly salted for a month, or hot smoked for twenty-four hours, cases would be found in which the thoroughness had been lacking and evil results would follow. Thus Benecke says he found live trichinæ in a ham and sausage which had been in brine for twelve days, then smoked and which he examined four and nine months afterward.

In veterinary sanitary police, the measures should be such as cannot be counterfeited nor evaded, and **thorough cooking** will prove such a resort. Trichinous hams, bacon, and sausage and indeed all pork products from a suspected source can be thoroughly cooked before they are put on the market. They may be canned in the fresh condition, or cooked as hams or sides and salted sufficiently to keep them indefinitely and the danger from trichina will be avoided. The heating must of course be so prolonged as to insure that no uncoagulated albumen nor red blood is left in the centre of the mass. The exclusion from the market of the trichinous carcase is not a necessity. It may be thoroughly sterilized by heat and put upon the market to be sold for what it really is, and it can be eaten with a confidence and security which cannot be accorded to all raw pork which has been examined by the microscope and pronounced to be free from trichinæ.

2. **Examine Microscopically all Pork Intended for Human Consumption.** This is not so absolute a protection as thorough cooking, yet so long as trichinous swine are sent to market, and the carcases of all cannot be thoroughly cooked, it is a most effective, though not an absolute safeguard. But, as in the cooking, so in this, the work must be universal, uniform and thorough. In Germany, where the habit of eating raw or underdone pork subjects the measure to its greatest test, epidemics of

trichinosis after eating inspected pork, are not uncommon. Inspectors grow careless, trusting to the immunity of swine in given regions, and when trichinosis has occurred in man, the faithless officer is subjected to fine and imprisonment. In other cases butchers mislead the inspector, secreting a number of carcases and selling them later, on the strength of a supposed general inspection. In this case the penalties are visited on the butcher.

In slight trichinosis, however, the worms being unequally distributed through the muscles, a number of examinations may be made before any are discovered. Leuckart has repeatedly made barren attempts until the tenth or twelfth trial, and Kühn after forty trials without result, found trichinæ to be abundant in other muscles of the same animal. The following table of the number of trichinæ found in particular muscles, serves to illustrate this variation, as well as their habitual abundance in given muscles:

				Müller	*Krämer*
1 grain	from	Psoas	contained	161	7
"	"	Diaphragm	"	129	8+
"	"	Laryngeal Muscles	"	126	21+
"	"	Lingual Muscles	"	105	4-12+
"	"	Orbital Muscles	"	64	----
"	"	Abdominal Muscles	"	54	7+
"	"	Masseter Muscles	"	45	14
"	"	Intercostal Muscles	"	8	7
"	"	Pectoral Muscles	"	33	9+
"	"	Scapulo-Humeral	"	18	28
"	"	Pelvi-Femoral Muscles	"	26	----
"	"	Tibial Muscles	"	26	----
"	"	Longissimus Dorsi Muscles	"	20	----
"	"	Radio-Ulnar	"	17	----
"	"	Gastrocnemius	"	—	12

In making inspections the muscles selected should include those nearest to the abdominal walls, and especially to the points of attachment of the mesenteries. In Hanover the diaphragm, intercostals and masseters are chosen. In Magdeburg the diaphragm, oculars, masseteric, cervical and costal. In the Bureau of Animal Industry the pillar of the diaphragm, psoas, inner side of the shoulder and base of the tongue. The material taken should be muscular tissue from close to its termination in tendon or fascia, which obstructing the progress of the wandering trichina, favors its encystment at this point.

Identification of Specimens. The pieces of muscle (each about the size of a hazel-nut) taken from one carcase must be placed in small tin boxes, that are then marked on the lid with the name of the muscle and a number which is stamped or tagged on the carcase from which the specimen was taken. The carcase may be split from nose to croup, but must not be further mutilated until it has been passed upon and tagged. The specimens are locked in a box and sent to the microscopist, who must examine them one by one according to number and make a report of the numbers borne by all trichinous specimens.

Examination of Specimens. In trichinosis of old-standing, with calcified capsules, these stand out as white specs on the red muscles, and are easily detected by the naked eye. Even the uncalcified capsules can often be seen with the aid of a lens. Place a piece of muscle, 1 mm. in thickness, in a solution of caustic potash (1:8), or acetic acid, in a watch glass for a few seconds until it has become clear, and look through it toward a black background. The capsules stand out as whitish specs. If the solution is left too long in contact, the capsules themselves become transparent and the test is no longer possible. Any such specimen must be taken as merely indicative and the presence of trichinæ must be verified under the microscope.

Microscopic Examination. This may easily be made under a compressor, with a low magnifying power (10 to 30 diameters) or more carefully with a higher (100 diameters). In any case the glass slides and covers must be carefully cleaned to avoid mistaking vegetable or other fibers for trichinæ.

For the low power, thin strips are cut from the muscle, parallel to the direction of the fibers, and five or six such pieces are laid side by side on a rather thin glass slide. This is covered by a similar slide and the two are firmly pressed together by screws at the two ends until the muscle appears transparent. They are now examined under the low power, when the free trichina, the fusiform sarcolemma containing the trichina, or the ovoid cyst, should stand out clearly. It is important to avoid taking adipose tissue or white or yellow fibrous tissue with the section.

For the higher power (and usually also for smoked or dried ham or pork) it is best to clear up the sections before mounting them. In this case the stripes of muscle are steeped for fifteen

minutes in solution of acetic acid (3:100), caustic potash (10:100), or glycerine (50:100), and then, or as soon as they have become transparent, placed on a glass slide, teased out with needles, and pressed under a cover glass, and examined. This must be done systematically piece after piece and covering the whole field in successive zones, the one hand being used to move the object and the other to work the fine adjustment, so that every part may be brought into perfect focus in turn.

The discovery of a large number of calcified trichinous cysts, does not imply that no live trichinæ are present. On the contrary, it furnishes evidence that the pig has been in a locality where trichina exists, and the older invasion implies the probability of other and more recent ones, so that all such cases may be held as highly suspicious, and should at least be subjected to a most exhaustive scrutiny. Better still, sterilize the carcase by heat.

Reference has already been made to other **parasites which may be mistaken for trichina.** If acetic acid is used to clear up the specimen it should be seen that it is free from **anguillula.** This may be grossly distinguished by the fact that it tapers to both ends, especially the caudal. The **larvæ of ascarides** and **strongyli** have the cephalic end broad, and taper toward the tail. The **filaria** of man and dog also taper toward the tail and show a special membranous caudal prolongation. None of these nematodes, nor the **rhabditis** form the characteristic ovoid cysts in the red muscular fibre, and they are not associated with the profusion of semi-microscopic intestinal trichinæ. The smallest commencing cysts of **cysticercus cellulosa,** or of **echinococcus** may be found in the connective tissue of the muscles, but they are differentiated by the globular head with its four sucking discs and the rows of hooklets on the rostrum. **Psorosperms** in the muscles of swine, sheep, cattle, etc., known as **Balbiana Gigantea, Rainey's cysts,** and **Mieschner's tubes,** appear in the form of an elongated ovoid mass, composed of an aggregation of cells, and without any sign of a convoluted worm in the interior. These may be so abundant that the flesh is soft, flabby, wet and yellow, green or gray. Isolated tufts of **actinomyces musculorum suis** may be mistaken for trichina cysts, the more so that they are common in the pillars of the diaphragm and in

the abdominal walls. They are more rounded than trichina cysts, usually much larger, and the surface shows a mulberry appearance from the clustering outer cells of the tuft which, like the mycelium, have a concentric arrangement. There is no enclosed worm. (See Actinomycosis). Unlike trichinæ this is common in the heart. Smoked hams sometimes show white points, visible to the naked eye, and due to the precipitation of **tyrosin** usually as needle-like crystals in bundles or sheaves. This is soluble in acids, alkalies or hot water, but insoluble in chloroform or ether. In the interfasicular muscular connective tissue of pork is sometimes found a young **ovoid distoma** with a sucker at one end and about 5 mm. in length. It is grayish in color, though usually with a red congested covering, and it moves actively when raised to the normal body-temperature. Like trichinæ this is found especially in the pillars of the diaphragm (Duncker, Leuckart, Pagenstecher, Hess), and in the laryngeal muscles (Happen, Muhle). Its genital organs are very rudimentary, indicating that the pig is an intermediate host and that its full development, by which it may be fully identified, must be looked for in some other animal. (See below, *agamodistoma.*)

The *embryo lung worms* (**Strongylus Paradoxus**) may be carried by the knife and lodged on the muscle, but may be distinguished by the broad head and anterior part of the body, the tapering tail and the absence of the characteristic cellular structure of the trichina. Finally in old, smoked, dried hams, cheese or sugar **mites** sometimes settle and might appear like cysts to the naked eye. A magnifying lens or microscope brings out their true structure and corrects this error.

Classification of Inspected Pork. Under the Bureau of Animal Industry inspected pork was classified as follows:

"**Class A.** Samples in which there are no signs of trichinæ, living or dead, calcified cysts, or other bodies or substances having any resemblance to trichinæ or trichinæ cysts." Ninety-eight per cent of all pork passes under this head. It is tagged as sound and certified for exportation.

"**Class B.** Samples in which there are disintegrated trichinæ or trichinæ cysts, calcified trichinæ or trichinæ cysts, or bodies having any resemblance thereto."

"**Class C.** Samples in which there are living or dead trichinæ bodies, not disintegrated."

Together these two last do not exceed 2 per cent.

"All carcases coming within Class C. are removed from the cooling room and disposed of by tanking, or they may be rendered into edible lard at a temperature of 150° F., or made into cooked meat products if the temperature is raised to the boiling point for a sufficient time to cook thoroughly the interior of the pieces. Carcases belonging to Class B. are rejected for shipment to countries requiring inspection and certification."

In the year 1899, over one hundred and twenty million pounds of pork were exported under this guarantee. The cost of inspection for that year averaged 0.142 cent per lb.

In 1907 the Dept. of Agriculture, Washington, abandoned the inspection of export pork for trichina. This had been kept up for many years for all such products destined for the foreign trade, but not for the domestic, and as the European States made no response, but continued to inspect all American pork on arrival, it was deemed undesirable to continue the attendant expense. A more radical sanitary campaign aimed at the protection of home as well as foreign consumers, and above all at the tracing out and extinction of every centre of trichina-infection in the land, would have had a more substantial *raison d'etre.*

FILARIA RETICULATA. SPIROPTERA (ONCHOCERCA) RETICULATA (CINCINNATI). FILARIA OF DIGITAL CONNECTIVE TISSUE AND SYNOVIAL SACS.

Formerly described as *Onchocerca Reticulata* and *Spiroptera Cincinnati;* this has now been remanded to the genus Filaria, with which it agrees in its form and structure, its habits and habitat.

The length of the parasite is not definitely known, as it is found wound around fibrous and muscular bundles and has not been successfully extracted entire. It is .35 to .40 mm. in diameter in the *female* and .15 mm. in the *male.* The length of the female is estimated by Neumann at 40 to 50 cm. The body is filiform and has the appearance of having been twisted, by reason of a series of cuticular ridges running spirally around it and connected through its substance by transverse filaments. Head without neck; mouth round, terminal. Tail of *male* excavated beneath and furnished with two lateral, vertical lobes with small hooklets

at their base and a papilla on the free border. Spiculum single, between the lobes. In female the vulva is near the head; the oviducts double and filled with ova and free embryos. Ovoviviparous.

Hosts. Habitats. The *Filaria Reticulata* has been found in *equine* animals only. Its usual habitat is in the connective tissue surrounding the tendons, especially the flexors, in the metacarpal region. It has however been found in the synovial sheaths of the flexor tendons, between the knee and fetlock, and in the connective tissue covering the ligamentum nuchæ. It was first recorded by Ferguson at Dublin in 1838 (Veterinarian); later by Hermann and Bleiweiss at Vienna in 1840. Since that date specimens have been found at intervals (Ercolani, Gurlt, Müller, Zurn, Baumgarten, Gotti, Baruchello, Bassi, Vigezzi, Tschudlowski, Popow, Railliet, Moussu, etc.)

Distribution. This appears to be extensive, embracing Great Britain, Ireland, Germany, France, Italy, Russia, Siberia, and America. At Kasan it is so common that Tschulowski found it in 51 of the 53 horses examined.

Age, Season. The worm has been found in horses of all ages, and at all seasons, though most frequently in spring and summer.

Symptoms. These may consist in lameness without any appreciable cause, in cases in which the worms are so deeply seated as to give rise to no visible swelling, or in cases in which the swelling has not grown to proportions that can be recognized. As the favorite seat of the worm is in the metacarpal or metatarsal region, those forms of halting which indicate that part as the seat of suffering may be suspected of a filarious origin.

When the local lesions are more obvious they may still be confined to distension of the synovial sheaths known as the carpal or tarsal arch (thorough-pin of knee or hock) or of the sesamoids (windgalls). In the absence of any sprain, puncture or bruise such synovial distensions may be punctured with a hypodermic needle, under antiseptic precautions, and the escaping synovia may be found to contain numbers of the embryos, 300μ to 400μ long by 6μ to 9μ broad, each showing a delicate digestive tube extending through its whole length.

The same is true of the synovia of the distended fetlock joint or of the first or second digital joint. The swelling and semi-

flexion indicate the implication of the joint, and the presence of the embryos explains its parasitic nature. Tschulowski found as many as three or four embryos in each drop of the liquid.

The same author has found the embryos equally abundant in the contents of the lymphatic vessels of the limbs, and in the perivascular lymph spaces. This may explain the occurrence of certain cases of lymphangitis, as it may of lymphadenitis. That these embryos reach the blood vessels through the lymphatics is inevitable, and the constancy with which the filaria, found in the connective tissue, is in near proximity to the blood vessels, strongly suggests their distribution in the blood stream.

When the worm in the connective tissue has caused the formation of a tumor, the latter assumes the form of a fibroma, of an ovoid shape and from one to two inches in its long diameter. The tumor is firm and resistant, being sometimes even calcified, but on incising it there are exposed canals containing a yellowish debris and a segment of the worm. These tumors are usually situated to one side of the perforatus tendon—inner, outer or posterior, but also though less frequently on the line of the flexor muscles in the forearm, or higher up, on the arm, shoulder, withers or neck (on the side of the cervical ligaments).

When present on the withers the condition may be readily mistaken for the infected lesion of fistulous withers.

Prevention. In most localities the cases of *Filaria Reticulata* are so rare that it appears unnecessary to apply preventive measures. The experience at Kasan, however, shows how prevalent and injurious the parasite may become in specially favorable conditions, and enforces the need of the usual precautions against the introduction of worms into the system. Water from deep, well-cemented wells, closed against surface dust, from flowing fountains having deep sources, or from cisterns, or the boiling, or other sterilization of the water (kerosene, phenol, naphthalin), would go far toward prevention, and the avoidance of infested, damp pastures and fodders grown on damp lands would be further suggested.

Treatment. When a hard parasitic tumor has already formed the proper resort is excision. It might be possible by vermicide injections to destroy the worm, but such a tumor would remain as a source of permanent irritation. The excision of the tumor,

however, removes the worm as well, and leaves a simple healing wound.

For the embryos in the distended synovial sheaths and joints, the antiseptic extraction, by aspirator if necessary, of the infested synovia, and the injection of a non-irritating vermicide. For this purpose a solution of pyoktanin (1:1000) with or without a small admixture of cocaine. Or a weak compound solution of iodine and iodide of potassium may be used; or, again, a weak solution of quassia in well boiled or distilled water. Such agents being absorbed into the lymph vessels, will tend to the destruction of the embryos that may have entered these channels.

PSOROSPERMOSIS FROM BALBIANA GIGANTEA IN RUMINANTS AND PIGS.

This sarcospore has been found extensively distributed in the voluntary muscles of the head and trunk, and in the heart, but especially in the œsophagean muscles of the ox, buffalo, goat, sheep and pig. It may vary in size from a grain of wheat to a hazel-nut, and is recognized as a whitish spot 3 to 5 lines in length by 1½ lines in thickness. It has a delicate outer membrane enclosing a mass of cells. In the centre of the larger ones is a capsule the size of a pin's head filled with arcuate or crescent-shaped non-nucleated bodies. The psorospermiæ may be of any number from two to two hundred, ten or fifteen being quite common.

They are not known to do any harm, yet Niederhausern and others believed them to be the cause of sudden deaths, because they had induced dropsical effusion in the vicinity of the larynx. The symptoms were those of asphyxia, and in other cases of epileptiform attacks.

OTHER PARASITES OF THE MUSCLES.

Cœnurus Serialis. **Ollulanus Tricuspis.** (See *Intestinal Parasites*). **Agamostoma.** (See below). **Filaria Hæmorrhagica.** **F. Medinensis.** **F. Irritans.** (See *Parasites of the Circulatory System*). **Hypoderma Bovis.** (See *Œstridæ*). **Symplectoptes Cavicola.** (See *Sarcoptidæ*). **Sclerostoma Pinguicola.** **Strongylus Gigas.** (See *Parasites of the Urinary Organs.*

Tænia Saginata (Bovis, Mediocanellata). T. Inermis. Beef T. This is the common tapeworm of Jews and Mahometans who reject pork, also of Abysinians who eat beef raw. It is besides the most common tapeworm of man in general in America, due doubtless to the liking for underdone beef (raw).

It is usually 4 to 10 yards in length (or exceptionally 5 to 8 times as long). *Head* 1.5 mm. to 3 mm., with four unarmed suckers giving it a tetragonal outline, and no rostellum. Neck much narrower, with at first transverse striæ, which gradually draw further apart from head to tail to form segments encreasing in length from before backward. These *proglottides* number 1000 and upward and attain a size of 16 to 20 mm. long by 4 to 7 mm. broad. Genital pores are marginal, mostly alternating (right and left) and placed slightly behind the centre of the segment. Uterus formed of a central stem with 20 or 30 lateral branches many of which are again branched so that the proglottis is literally crowded with this ovigerous organ. Ovum has delicate shell and two polar filaments. Anomalies and malformations of the worm are peculiarly common—dark pigmentation, two genital pores and sets of sexual organs in the same proglottis on the same side or on opposite sides, triangular segment, the merging of two or more proglottides into one, a V shaped outline on cross section from a segment becoming doubled laterally, a perforated (fenestrated) proglottis etc.

Habitat. The *mature tapeworm* inhabits the small intestine of *man* only. The suckers are usually fixed to the mucosa near the pylorus, but in rare cases in the stomach.

Evolution. The bipolar filamented *ovum*, produces the *onchosphere* or *six hooked embryo* (proscolex) which introduced into the bovine alimentary canal, (in calves especially) bores its way into the muscles or connective tissue and there encysts itself producing the *beef measles.* Experimentally and very exceptionally the scolex has been developed in lambs and kids (Zenker and Heller), as well as calves.

Küchenmeister had previously established the fact that bladder worms were but the larva of tapeworms and in 1861 Leuckart fed the proglottides of the tænia to calves and developed the cysticercus saginata in their muscles. Conversely in 1869 Oliver and Perroncito and his students developed the mature T. Saginata by eating the raw meat of *measly* cattle.

Cysticercus Bovis (Saginata). Bladder Worm Larva of T. Saginata. Ovoid or rounded cysts found in the interfibrillar connective tissue of the voluntary muscles, tongue (especially the pterygoid), masseter and cardiac muscles of calves, and less frequently of mature cattle. Found very rarely in the lungs, liver, brain, gullet or lymph glands of these animals.

It is gray, translucent, and enveloped in an outer connective tissue capsule, formed by the exudate and productive irritation caused by the presence of the parasite. The size varies according to the age of the cyst from a pin head to a pea. The proper capsule of the cyst is a firm membrane, smooth and even, externally and internally, except where it becomes continuous with the head. The head can be invaginated within the sac and then appears through the walls as a solid white body opposite the pore and movable in the interior of the sac. If protruded from the sac, for feeding or by pressure, it shows under a low magnifying power the solid quadrangular outline, with a sucker on each angle, and without rostellum or hooks. It varies in size from a millet seed to a hemp seed. The neck of the scolex is sparsely marked with calcareous corpuscles, and the sac more or less corrugated. In the live calf symptoms are usually wanting. With heavy infestment however there may be emaciation, weakness, fever, dermatitis, anorexia, tympany, wasting and even death. The cysts may be sought under the tongue or by harpoon in the muscles, as for trichina.

Diagnosis of Cysticercus. The presence of the above mentioned bodies in beef carcases is conclusive. The scolex may however be overlooked on the surface when dried, but on section it stands out clearly. The presence of the six hooked embryo not yet fully developed into a cyst is usually overlooked; there may however be detected a small area of vascular irritation and even of blood extravasation, and microscopic investigation will detect the tapeworm head. If there is doubt as to the nature of the small cyst, pressure will cause protrusion of the head which is unmistakable. The calcareous corpuscles are diagnostic. Examination of the masticatory and cardiac muscles should never be omitted.

When the meat has been minced (for sausage) a portion is digested for several hours at 102° F., in 6 or 8 times its bulk of

artificial gastric juice, made by mincing the gastric mucosa of the pig and extracting the same with 0.5 per cent of muriatic acid. The digested tissues, including the outer connective tissue layer of the cyst, float on the surface of the liquid while the more resistant cyst or scolex falls to the bottom where it can be easily recognized by its white ovoid form, its transverse striæ and its protractile head. The peptic solution will keep indefinitely if made from the pig's minced gastric mucosa kept in glycerine for some days, then filtered and bottled up. The HCl can be added just before using.

Rissling advises using a strong soda or potash lye so concentrated that even the almost fat-free muscle floats on its surface. After it has become clear by standing, it is placed in a wide mouthed vessel of a capacity of three or four litres and tapering toward its lower end. The mince-meat is stirred up with a little of the lye to form a broth, and is then added to the lye in the vessel. This is constantly stirred and water added until some of the particles of muscle fall to the bottom. These being now the heaviest particles contain the cysticerci which are easily recognized by teasing and examination with a power of 20 diameters.

It is not likely to be confounded except with cysticercus tenuicollis and echinococcus but the *first* is only found on the surface of the bovine muscle under the serosa or in the liver, and the *second*, even when found in the muscle, is usually multilocular and many of the cysts are sterile (acephalic). The heads in both these larval tapeworms, are furnished with hooks.

Danger to Man. While much more common in civilized communities than the pork tapeworm, that derived from cysticercus bovis is much less dangerous to the human host, as there is no satisfactory evidence that it can, in man, infest any part save the intestine. The pork tapeworm may invade the brain, muscle, liver, etc., in its larval form, producing nervous and even fatal disorders. The infestment of man by the beef parasite can never come from the ova, but only from the eating of the infested beef, or from taking in the mature larva derived from such meat. The immature larva, with suckers undeveloped, is incapable of living and developing in the intestine of man, and the old cysticercus calcified and degenerate is already devitalized so as to be harmless to the person consuming it.

SANITARY MEASURES.

Even the fresh meat with mature, live scolexes can be rendered harmless as follows:

a. *By preserving* the infested carcase for three weeks in a refrigerating chamber, the scolex perishing in the dead muscles in that period of time.

b. *By freezing* the infested beef, at 5° F. for 14 days the scolex is killed (Glage). The cysticercus becomes immobile, sticky and receptive of staining solutions. In dried veal Perroncito found that the cysticercus died in 14 days after the calf was slaughtered.

By either of these methods the beef may be rendered safe without affecting its freshness, but it must be used very soon after thawing as its keeping qualities are greatly impaired.

c. *By boiling* the infested beef until it has reached a high temperature throughout, and has changed from blood red to gray in its centre. This gray color, implying coagulation of the albumen, is reached at a temperature of 150° F. Hertwig further notes that the cyst, which has normally a great resistance to pressure, can after boiling be easily pressed out flat, like a piece of fat, between two plates of glass. Boiling however greatly depreciates the weight of the beef and otherwise lessens its value.

d. *By salting*. Perroncito demonstrated that the scolex perishes in 24 hours in a strong salt solution. The time required for the penetration of the salt depends on the thickness of the pieces; if two inches thick it will be thoroughly salted in fourteen days; if injected into all parts with a brine syringe (Glage) this may be accomplished sooner. A test of complete penetration is made by drying the surface of the salted meat, cutting it through the centre and applying to the centre a few drops of a 1% solution of silver nitrate. In the completely pickled meat a milky cloudiness is temporarily formed by precipitation of silver chloride.

Carcases and cuts, infested and treated as above must be indelibly marked and carefully supervised until testified sound.

Danger to Young Cattle. Men harboring tænia saginata should be treated for destruction and expulsion of the worm, and effective precautions taken to prevent the scattering of their

stools, and the ova of the parasite on pastures or waters open to young cattle.

Tænia Solium. T. Pellucida. The Pork Tape-worm. Smaller than T. Saginata (ovum, onchosphere, scolex, strobila and proglottis), this is notwithstanding more dangerous to man as it not only lives mature (strobila) in his intestine, but also in solid tissues (muscle, liver, brain, etc.,) as larva (scolex). The human system may thus become infested by eating the scolex in infested pork, but also by swallowing the ovum or onchosphere in water, salads, and uncooked vegetables and fruit. In the brain it may cause serious nervous, mental and even fatal disorders. The term *solium* is a misnomer as usually understood; as many as 41 strobila have been found in the same human intestine (Klufeld). The term is not from the Latin *solus*, alone, but from the Syriac word for *chain* (Leuckart).

The *mature worm* averages 3 to 4 mm. in length, and the proglottides are broader than long in the first metre, while the sexually mature segments, in the last metre, measure 10 to 12 mm. long by 5 to 6 mm. broad. The head is tetragonal with a hemispheroidal sucker on each corner, and in the centre a prominent rostellum, often pigmented, and provided with a crown of 22 to 32 hooklets arranged in two rows a large and small hook regularly alternating. After a narrow transversely striated neck of 5 to 10 mm. long the striæ widen out to form *segments*, at first broad and short, but becoming quadrate about one metre from the head and behind this, encreasingly long in proportion to the breadth. The genital papillæ and pores are on the edge of the proglottis alternating irregularly in successive segments. The ovarian lobes are three in number, a small one near the genital pore, a larger one on the opposite side, and the smallest in the angle of the vagina and uterus. The uterus has a central anteroposterior stem, with eight to ten lateral branches giving off smaller branches in their course. These branches are larger but less freely branching than in tænia saginata.

The eggs are ovoid, 0.031 to 0.036 mm. in diameter, with delicate outer and thicker inner shell, and no polar process as in the saginata. The *onchosphere* (*embryo*) is round, six-hooked, and 0.20 mm. in diameter.

The *larva* (*scolex*) known as **cysticercus cellulosa** is usually found in the connective tissue between the voluntary muscular

fibers of pigs, in the adipose tissue, tongue, heart, around the anus, in the eye, lymph glands and brain, and less frequently in the lungs, liver, spleen and kidneys. Beside swine wild and tame, the scolex infests man, dog, sheep, deer and according to Braun rats and apes. There is reason to suspect that in the sheep and deer a careful examination would have demonstrated an undeveloped cysticercus tenuicollis in place of the C. Cellulosa:

The *Cysticercus Cellulosa* is a resilient, ovoid body 6 to 20 mm. long, and 5 to 10 mm. thick, through the transparent walls of which the inverted head may be seen with the naked eye as a whitish spot. When squeezed out the head shows the general characters of the T. solium, with its prominent rostellum, and, if mature, its double row of hooks.

The *growth* of the cysticercus is slow: on the 21st day it reached 0.8 mm. and in 32 days 1 to 6 mm., in 60 days it is 7 mm; in 100 days the size is uniform 10 to 20 mm. By the end of the third month it is believed to be ripe and fitted for survival in the human intestine. The *vitality* varies with the environment: the scolex dies very soon when free in ordinary water, while in flesh at normal room temperature it lives for twenty-seven days (over 42 days, Ostertag). A scolex in the eye has maintained its vitality for twenty years as shown by the ophthalmoscope.

Diagnosis. In the living pig, the lower surface of the tongue by the side of the frænum, being a common seat of the parasite, is a favorite place for examination. The pig is thrown on its side, the mouth opened with a stick, the tongue drawn out with a cloth, and its lower surface critically examined by sight and touch for the firm, round cysticerci. A similar examination is made of the delicate tissues around the anus and in the orbit. *Post-mortem*, if the voluntary muscles are not so heavily infested as to show the presence of the cysticerci at once, careful examination should be made of the tongue, the subscapular and subhumeral muscles, the pectorals, triangularis sterni, the intercostals, fleshy part of the diaphragm, the psoæ, the muscles of the heart, neck and thigh. In the heart they mostly accumulate near the apex. When there are few and there is any doubt as to the nature of a firm ovoid body met with, the latter should be firmly pressed between thumb and fore finger until the head is protruded, and

this under a low magnifying power should give all the characters of the tænia solium.

C. tenuicollis, the only one likely to be confounded with C. cellulosa, is easily distinguished by the incomparably greater size of the cyst, by the much longer and more attenuated neck, by the number of hooks on the rostrum (32 to 40 in place of 22 to 28 of C. cellulosa), and by the greater length, tenuity and curvature of the point or blade of those of the tenuicollis.

When the muscles are badly infested, they are pale, flaccid, infiltrated and moist, and decidedly repulsive to the consumer. The hosts in such cases are usually in low condition, and may, in life, have shown such symptoms as stiffness of the neck, or fore limbs, arching of the back and a disposition to remain recumbent. When cysticerci are old, dead and caseated or calcified, the true nature of the tubercle-like masses, may be easily decided by the presence of the chitinous hooks which are slow to undergo disintegration or change. The degeneration begins with the membranes of the cyst and ends with the scolex and hooks. When however degeneration has commenced at an early stage of the development of the cyst, the hooks may as yet be wanting, and their absence from the debris leaves the case a more equivocal one.

Even when the butcher has scraped off the superficial cysticerci with his knife, the ovoid cavities which they occupied will remain, and should lead to further, deeper and very thorough investigation.

If there is difficulty in detecting the cysts in mince meat, the tests by peptic acid solution, or by alkaline liquid, as advised for saginata, should be applied.

It should be added that with cysticerci in the brain there may be almost any form of nervous disorder: unsteadiness in walking, turning to one side or in a circle, convulsions and blindness are among the most common manifestations, while grinding of the teeth, champing of the jaws, salivation, local spasms, encephalitis, or delirium may be present.

Greve claims that infested pigs have the snout abnormally sensitive so that they avoid rooting even in soft ground, eat with difficulty from a hard surface using the tongue to take in the food, and cry out in pain if the nose is tapped lightly with a stick.

On the other hand the tongue may be so sensitive that the pig cannot take in his food. In badly infested, chronic cases the pigs are weak and paut if driven, drag behind the herd, lie down and refuse to rise. Dropsical effusions may appear in different parts of the body and on the mucosæ, anorexia and diarrhœa may set in, the heart beats weakly and irregularly (palpitates), the mouth becomes fœtid, and the gums pale and anæmic, yet spongy and ready to bleed.

Ratio of Infestment of Different Tissues. As the most dangerous infestment of the human subject is by the cysticerci it is well to note the ratio in which the more vital organs are implicated. As quoted by Ostertag of 159 persons suffering from C. cellulosa the brain was involved in 116 cases, and the muscles in 33. In 14,000 *post mortems* in Munich, Bollinger reports but two with cerebral cysticercus. In 80,000 patients with diseases of the eye, von Gräfe found 90 had cysticercus in the organ. In 60,000 eye patients in Berlin, Hirschberg found the trouble due to C. cellulosa in 70 cases. In the following six years however only 2 such cases were presented in 46,000 eye patients. This last period corresponded with a progressive elimination of *measly* pork from the markets through rigid inspection. The list shows the most urgent danger of grave and fatal infestment in the absence of proper supervision of the pork market.

Prevention. Careful, and general inspection of pork has reduced the prevalence of *tænia solium* in man almost to extinction. This is not yet true of swine, so that neither inspection, nor the thorough cooking of every pork product can be safely omitted. Measures corresponding to those advised for tænia saginata must be maintained but they must be more intensive and far reaching.

a. In *cooking*, every part of the ham or roast must be raised to 122° F. as the larva will often survive any lower temperature. "Measly pork is to be considered as harmless if it has been boiled so that the *cut surface* presents an uniformly white color," 150° F. (Ostertag.) The same applies to roasts, broils, etc. General sterilization should be done under official sanitary supervision.

b. Mere preservation of the carcase in cold storage is not sufficient; after 42 days the larva is still alive.

c. A thorough salting destroys the vitality of the scolex, but the same lapse of time, and silver tests are desirable as in the saginata. The same indelible marking of the infested carcase is requisite before it can pass into consumption.

d. *Protection from ovum and embryo.* The danger for pigs does not come directly from other infested pigs as the hog does not harbor the mature ovigerous strobila, and the encysted larva, even if eaten by other pigs, cannot make its way into their tissues to become encysted anew. This renders imperative the thorough treatment of all cases of pork tapeworms in man, and above all in localities where infested pigs have been found. The discovery of infested pigs in the course of abattoir inspection should be followed by the tracing of such pigs back to their yard, field or pen, and the sanitary investigation and cure of all cases of pork tapeworm in the human race in the vicinity. A sanitary order should be enforced in any such locality preventing the escape of the fæces through short sewers, against defecation in pastures, yards, pens etc., to which pigs have access, and against the spreading of untreated night soil on any such place. Gerlach found that pigs over six months old were not infested in his experimental cases, so that for old breeding swine the lines need not be drawn with the same strictness.

To obviate the most dangerous infestment of man, the entrance of the embryo into the muscles, brain etc., special precautions are requisite. As man is autoinfesting, the ripe proglottides, escaping with the fæces, or in the intervals between defecations, crawl over floor, walls etc., and scatter the ripe ova to mingle with food and water and finally reach the human stomach. The ripe segments may even lay the ova in the intestines before expulsion, and if hatched there, the embryo may at once bore its way into the mucosa and encyst itself in the tissues, without having passed through any external existence. For self preservation therefore, as well as for the health of the public at large, the person who harbors a pork tapeworm should be officially dealt with, and compulsory measures applied for destruction and expulsion of the worm.

Tænia Krabbei, found in the small intestine of the dog in Northern Europe, is represented in larval stage by the **Cysticercus Krabbei** (**C. Tarandi**) which infests the muscles and

connective tissue of the reindeer. This is smaller than the *Cysticercus Saginata* and invades mainly the spinal and intercostal muscles. The parasite has 26 to 34 hooklets, clearly differentiating it from *T. Saginata* to which the *Cysticercus* corresponds in size. At the Zoological Gardens at Lisle, France, Moniez raised the T. Krabbei in dogs from armed cysticerci taken from the reindeer.

MUSCLE FLUKE OF SWINE AGAMODISTOMUM SUIS.

Stiles and Hassall record the discovery by Charles Bullard, inspector at Buffalo, of an immature agamous fluke in the muscles of hogs slaughtered there. It is very small, elliptical, with central cephalic and ventral suckers, enclosed in an ovoid cyst, lodged between the muscular fibres after the manner of Rainey's cysts (Sarcocystis Miescheri) and to be discovered only under a low power of the microscope. No characters have been noted sufficient to give it a definite place in the family, so that it is an open question what host it attacks in its mature form, and whether dangerous or not. It is probably identical with the form in Europe, described by Leunis and Leuckart as *Agamodistoma Suis*, or, as suggested by Stiles and Hassall, it may possibly be a young form of the lung fluke (*Paragonimus Westermannii*), the metamorphosis of which has not been worked out.

It does not seem to be in any respect injurious to the pig harboring it, and it cannot harm the human being who consumes the pork provided the latter is sufficiently cooked. If it could be shown to be the *Paragonimus Westermannii*, there would arise the question of the propagation of this new and dangerous parasite on American soil, and the thorough cooking to sterilization of every infested carcase, and of all others in the same herd, and the abandoning for hogs, of the infested area would be appropriate. The identity, however, of the two parasites is as yet a mere hypothesis, and may be said to be rendered doubtful by the absence of the lung fluke from the same hogs and locality, and the absence of the muscle distoma in the hogs that elsewhere harbored the lung fluke.

PARASITES OF THE NERVE CENTRES.

Parasitic invasion of the brain, spinal cord and ganglia must be accorded a wide range if we take into account the various microbes that survive in the circulating blood. These are however to a large extent accidental, yet some like the *negri bodies* localize themselves in the plexiform ganglion, and those in and around the medulla oblongata, producing the most marked and destructive nervous disorder. All *blood-infecting bacteria*, all *pyroplasmata*, all so called *malaria-producing organisms*, and the whole family of *trypanosomata* circulate in this way through the nerve centres. *Coccidia* must be included in this list.

Coming to the larger parasites we find many that invade the blood in their embryonic stage and circulate through the brain even if they do not rest there to produce appreciable nervous trouble. Thus we find in the blood the embryos of *Filaria papillosa*, *F. irritans*, *F. medinensis*, *F. immitis*, *F. cervina*, *F. recticulata*, *Strongylus vasorum*, *S. gigas*, *S. pusillus*. *Sclerostoma*, *Oxyuris*, *Stephanurus*, *Ollulanus*, *Trichina* among the round worms, while among cestoids are the embryos of the *cysticerci* generally, the *Cœnurus cerebralis* and *serialis*, the *Echinococci* and the *Bothriocephali*.

Of the *Cestoids* some occasionally and others habitually become encysted in the brain or spinal cord producing serious results. Among the former is *Echinococcus* and *Cysticercus cellulosa*, and among the latter *Cœnurus cerebralis* and *C. Serialis*.

Larvæ of Œstridæ in their migrations are known to have reached the brain or spinal cord with dangerous and fatal results. Both horses and cattle suffer in this way and the result is usually a fatal one.

Cold in treatment of Cœnurus Cerebralis. Gieres, Hartenstein and Nocard had excellent results from treating cœnurus invasion of the brain by continuous irrigation for 3 days or more with cold water and still better from applying a bag of crushed ice to the cranium. The affected animal is placed in a box with the head projecting through a hole so that the fleece and body can be kept dry, while the water is discharged through a rubber tube on the cranium alone. The animal remains quiet after 15 or 20 minutes irrigation and there is decided improvement after the first day. Recovery follows in 15 or 20 days of treatment, in foals, calves and lambs.

PARASITES OF THE EYE.

Coccidia in ocular muscles : Ox, dog, cat. *Muscæ, tabanus. simulium,* and *chrysops* attack eye. *Hypoderma* under cornea. *Lice* on eyelids and lashes. *Sarcoptes, demodex, trombidium* and ticks on eyelids. *Leech* on conjunctiva. *Cysticercus cellulosa* in submucosa, in muscles or connective tissue, in aqueous, choroid or retina. *Echinococcus: Trichina* in ocular muscles. *Filaria Oculi Equina: F. Papillosa. Distribution:* India, Ceylon, Burmah, Europe and America ; on low, damp soils, mostly in cool season, but in more temperate zone at all seasons. Body thread like, white, mouth terminal, small, without papillæ, tail acute with two strong lateral papillæ directed backward ; 30 to 35 mm. long ; ovoviviparous. *Symptoms* variable, photophobia ; closed lids, epiphora, congested mucosa, clouded or vascular cornea, one or both eyes invaded, one or more worms in aqueous of each. Connection with filaria of peritoneum and paresis. *Treatment :* Incision near margin and parallel to cornea under careful antisepsis, extraction of worm, antiseptic collyria. *F. Oculi Bovina : F. Cervina :* In France, Belgium and Italy ; in damp localities, at all seasons. *Symptoms* variable, as in soliped ; one or both eyes affected ; one or more worms in each. *Treatment :* Puncture and extraction as in horse ; aloes, mercury sulphate, sulphur. Leech-like parasite in sheep's eye. *F. Trispinulosa* in dog's vitreous. *F. Mansoni* in eye of hen, etc. Parasite in aqueous of geese. *F. Palpebralis :* white, cylindroid ; small terminal mouth, nude ; gullet club-shaped ; 8 to 15 mm. long. Male has tail curved, female, straight tail, ovoviviparous. Found by Gurlt and Goubaud in Germany and France in subjects of dissection, and without visible ophthalmia. Subpalpebral, in lachrymal ducts or sac. Epiphora, congestion, photophobia, tenderness, opacity and erosion of cornea. Diagnosis by finding the worms. *Treatment* : Pick out worms with forceps, wash out with syringe, apply wormwood, quassia or aloes solution. *F. Lachrymalis :* In conjunctival sac, lachrymal duct and sac of ox ; 10 to 24 mm. long ; very inequal spicula ; embryo large. *Symptoms :* Presence of the worm, with or without conjunctivitis. *Treatment :* Extract worm with forceps ; wash out with stream of water ; use harmless vermifuges, quassia, aloes, tincture of camphor, wormwood infusion. Astringent, anodyne collyria.

Sporozoa. Coccidia were found by Krause in the ocular muscles of the ox, dog and cat.

Diptera. Different flies are attracted to the eyes of animals, the muscæ to suck the tears while the tabanus and simulium dash into the eye attracted by its glitter. The chrysops coecutiens takes its name from its propensity to attack the eye.

Van Setten, Onderdenham, Holland, extracted through an incision in the cornea of a horse, a parasite, which Blanchard and

Railliet claim to have been the larva of an œstrus probably a *hypoderma.*

Pediculidæ. When lice abound on the surface of the body they are quite liable to attack the palpebræ and often lay their eggs on the eyelashes. The species are those peculiar to the animal attacked and may be either hæmatopinus or trichodectes. An ointment of yellow oxide of mercury will usually correct the blepharitis and destroy the parasites.

Acarina. Sarcoptic Acari when colonized on the skin of the head are especially prone to attack the soft skin of the eyelids. The **demodex folliculorum** invades the Meibomian glands of the dog (Railliet), horse (Wilson) and sheep (Oschatz). These, too, may be successfully treated by mercurial ointment.

The **silky trombidium** has been found in the canthi and along the margins of the lids in dogs in summer and may be treated in the same way. **Wood ticks** (**ixodes**) also attack the eyelids.

Leeches. The **horse leech Hæmopis Sanguisuga**) has been found on the conjunctiva of the horse in Algiers (Bizard). Guyon had previously noticed a similar occurrence in the eye of a soldier in the same country.

Cysticercus Cellulosa. This larval cestode is not infrequent in the orbit or even in the eyeball of pigs which are otherwise infested by it. Its common habitat is under the mucosa of the eye, where it appears as a white ovoid body as large as a barley grain. It may also be felt if not seen in the muscles of the eyeball or between them.

Nordmann describes four cases of its presence in the interior of the eye, twice in the anterior chamber, once in the posterior chamber accompanied by cataract, and once in the vitreous, associated with blood extravasation and calcified sclera. Gescheidt records two cases, of which one was in the anterior chamber and one between the choroid and retina. Van der Hoeven records an additional case of this kind.

Cunier found a cysticercus beneath the mucosa in the outer angle of a dog's eye, and Heincke found one in the orbit of a fourteen day old colt, which had the eye atrophied. In these cases the species is left uncertain. Finally Hutchinson found a cyst in the anterior chamber of a horse's eye but failed to find

any head of a cestode. The double membrane constituting the walls and the translucency of these and the contents suggested cystic tape-worm, while the absence of the head would be in keeping with the brood-capsule of an **echinococcus.**

Trichina. The ocular muscles, in common with those of other parts of the body, harbor the trichina spiralis, but the presence of the parasite cannot be certainly diagnosed during life unless the trichina harpoon is used. Swelling and congestion of the conjunctiva, and epiphora associated with general stiffness, and irritable bowels may be present in such cases.

FILARIA OCULI EQUINA. FILARIA PAPILLOSA. FILARIA PELLUCIDA.

The presence of a thread-like worm in the eye of the horse is mentioned by Spigel (1622), and by Rayo in Spain, in horse and mule (1773). Morgan and Hopkinson records a case in the horse's eye as exhibited in Philadelphia, in 1782. In the 19th century it has been especially observed in the horses of India, Ceylon and Burmah, but also not infrequently in Europe and America. In one case occurring in New York the author extracted the worm through an incision in the margin of the cornea and restored the vision of the animal. It is said to be unknown in Arabia and Persia.

Gibb, who resided for sixteen years at Posaah, India, on a low damp soil, constantly water-soaked, and covered with puddles, saw on an average twenty cases per annum. The wetter the season the greater the number of succeeding cases. These occurred mostly in the cold season, never before the month of October nor after the first of March. In colder latitudes this does not hold, Skeavington reporting three cases in March, May and September, Smith (Toronto) and Kennedy (India), one each in May, and Lee (New York) one from February to June. The young suffer more frequently than the old.

The identity of this parasite has been disputed. Kennedy makes it a distinct species (Filaria Pellucida), Grassi, the F. inermis, and Neumann and Rivolta consider it the young of the F. papillosa. Davaine's description is as follows: body thread-like, reddish white or chestnut, and a little expanded in its cephalic quarter; integument smooth; mouth furnished with three

triangular lips; tail acute with two long and strong papillæ at the sides, a little in advance of the end and directed backward. *Male* 30 to 35 mm. long, tail spiral and having between the two caudal papillæ, six papillæ on each side—three pre-anal and three post-anal; three short spicula, one smaller than the others. *Female* 22 mm. to 32 mm. long, genital tube destitute of ova.

Grassi's description is as follows: The female only is known. Body white or brownish, flaccid, slightly attenuated at the extremities. Integument striated transversely and longitudinally. Head without papillæ. Mouth terminal, very small, without papillæ. Œsophagus slightly enlarged in the posterior portion. Anus 300μ from the caudal extremity. Vulva 50 to 104μ from the mouth. Ovoviviparous. Embryos 350μ long, 5½μ thick, slightly narrowed in front and with finely pointed tail. Neither of these agrees perfectly with the Filaria papillosa of the serous membranes and the question of identity may be left unsettled.

Symptoms. Exceptionally the worm causes no inflammation, and it can be seen actively bending and unbending itself, in the form of a loop, a figure of 8, or a spiral in the anterior chamber. Usually there is considerable inflammation, closure of the lids, watering of the eye, redness of the mucosa, clouding and even vascularity of the cornea. Still in the majority of cases a portion of the cornea remains sufficiently transparent to allow the movements of the worm to be seen. Sometimes it will temporarily retreat through the pupil and disappear behind the iris.

Sometimes only one eye is invaded, in other cases both eyes, and in certain instances two or even three parasites are found in one eye.

In Hindostan the filaria oculi is not infrequently associated with a weakness of the kidneys called kumree or ah-drung, but the English army veterinarians look upon this as a mere coincidence. The wet hot regions infested by the filaria oculi, are equally favorable to the preservation of the parasites and microorganisms of other diseases.

Treatment. Rayo, who was the second to record instances of filaria oculi equina, also furnishes a successful case of treatment by puncture of the cornea (1773). The puncture may be made standing, the eye having been first rendered insensible by the application of a pledget of cotton wool dipped in a 4 per cent. solu-

tion of cocaine and then disinfected with a mercuric chloride solution (1:5000). The incision is made close to the margin of the cornea with a narrow-bladed lancet or cataract needle which has been first sterilized in a carbolic acid solution (1:30), and then dipped in boiled water. The upper margin of the cornea is usually selected, and the point of the lancet directed parallel to but in front of the iris. The escape of the aqueous humor usually brings with it a portion of the filaria which is at once seized with forceps and extracted. Should it fail to protrude, the sterilized forceps must be introduced and the parasite seized and withdrawn.

The operation can be accomplished more deliberately and accurately if the animal is subjected to general anæsthesia. The fixation of the eye may be made more perfect by seizing the sclera with rat-tooth forceps.

The subsequent treatment is by antiseptic collyria (mercuric chloride 1:5000) and bandage as in other cases of puncture of the cornea.

Grellier claims that he destroyed the worm by mercurial applications to the eye, and Skeavington by a course of alteratives. These may be more effective if the worm is already approaching the limit of its existence. When the worm dies in this way it may be dissolved and completely absorbed in four or five weeks. Quassia or pyoktanin solution may be applied. An early operation is however to be recommended as obviating the risk of permanent opacities and other changes destructive of vision.

Filaria Oculi Bovina. Filaria Cervina. Filaria Terebra. Filaria Labiato-papillosa. As in the case of the filaria oculi equina the identity of this worm is uncertain. It is, however, considered by Neumann and Railliet that it is the young form of the filaria of the serous membranes of the same animals, and which is also found in those of the deer and reindeer.

A worm in the aqueous humor of the ox was observed by Grisoni as early as 1429 but it does not seem to have been again observed until 1812 by Dégouilleme. Later it has been noticed by a number of observers including Santin, Chaignaud, Roche Lubin, Anceze, Cruzel, etc., mainly in France and Italy.

Causes. Like filaria oculi equina, it has been found especially in connection with damp localities, wet seasons and inundations,

and its prevalence has appeared to diminish in connection with the encrease of land drainage, the cultivated forage, a richer dietary and better stabling. It has shown itself to be rigidly confined to certain infested districts, as in France, to the valley of the Garonne. Claes and Brouwier record a local epizoötic in Belgium which was followed by bronchial strongylosis. Season appears to exercise a marked influence, thus Chaignaud who records over one hundred and fifty cases, found them only from June to November. Faure, however, saw a case in April, and Durechon and Roche Lubin, others in March.

Symptoms As in the horse the usual result is an ophthalmia of variable intensity, yet the cornea commonly retains a sufficient translucency to allow the worm and its movements to be detected in a good light, as at a door or window. In some cases there is little inflammation and the discharge of tears is the only prominent symptom to draw special attention to the eye.

The affected eye may contain but a single worm, but in exceptional cases two, three or four have been found, and Roche Lubin extracted as many as seven from the one eye. Both eyes may be affected at once or successively, and successive worms in the same eye are not uncommon, carrying the disease over four months with intermissions (Durechon).

It is claimed that the worm may be quiescent in its early stages, though actively mobile later, and Dégouilleme claims that at first there may be observed in the lower part of the anterior chamber small grayish white pea-like bodies representing the cysts from which the worms escaped.

Treatment. The most certain and effective treatment is extraction of the worm by puncture, as in the horse. Medicinal treatment has, however, been much more largely resorted to in cattle. Lafosse used local applications of absinthum, salammoniac, sulphate of zinc or nitrate of silver. Chaignaud dropped inside the eye-lids a solution of tincture of aloes in an equal amount of distilled water and found that the parasite dropped and became immovable in three or four days. Its absorption required several weeks, during which cooling astringent collyria were applied. Faure gave sulphate of mercury by the mouth (1 dr.) with sublimed sulphur (2 drs.) in a mixture of dry bran. The motions of the worm ceased in four or five days. Pyoktanin locally may be used.

If cataract is present before treatment is begun, it of course remains as a permanent lesion.

Parasites in the Eye of the Sheep. Haselbach has furnished the one example of this kind. A ram manifested sclerotitis, opacity of the cornea and photophobia, with a disposition to rub the eye, was treated for the same, and in three days, when the cornea had cleared somewhat, a white filament with active leech-like movements, was observed in the aqueous humor. The ram shook his head violently to escape restraint and the parasite disappeared behind the iris. The cornea clouded over anew six days later, and cleared up again under treatment by laudanum, but although the ram was kept under observation for nine months no worm reappeared.

Filaria Oculi Canina. Filaria Trispinulosa. This worm was once found by Gescheidt in the vitreous humor of a six year old dog. It was 7 mm. in length, cylindroid with a slight narrowing toward the tail, round mouth with three small, round papillæ. The hyaloid and vitreous in its vicinity were somewhat clouded.

Filaria Mansoni in Chickens. Railliet records the frequency of entozoa in the eyes of wild beasts, and Neumann the frequency of filaria in the blood of ravens and magpies in Eastern Asia. It is interesting to note in this connection the record by Cobbold of Filaria Mansoni in the eyes of chickens in China.

Entozoa in the Eye of the Goose. Small found among geese, which frequented a stream with a filthy bottom, in the vicinity of Dublin, Ireland, a great prevalence of an unilateral ophthalmia. The cornea became cloudy, and the bulb gradually encreased in size until it projected outside the orbit causing intense pain. One goose was sacrificed and the cornea incised when there was found in the aqueous humor a black vermiform object comparable to a young leech. Neumann suggests that it may have been a filaria. Small says the stream contained a number of leeches.

Filaria Palpebralis (*Conjunctivæ : Inermis : Peritonei Hominis*). Grisoni who first described the Filaria oculi, also reported the Filaria palpebralis on the conjunctiva of the horse in 1429. Gurlt described it in 1831, and Kliem in 1839. It has been described by Goubaux, Serres, Lafosse, Baillet, Railliet, Neumann and others.

The worm is whitish, cylindroid and only slightly attenuated at the ends. Mouth terminal, very small without papillæ. Œsophagus short and becoming more spacious posteriorly. Anus almost terminal. Integument non-striated. *Male* 8 to 14 mm. long. Tail curved in an arc, and showing near its end two inequal spicula. *Female* 14 to 15 mm. long. Tail straight. Ovoviviparous.

Gurlt and Goubaux found these worms frequently in horses received for dissection and the eyes of which were apparently sound. They were found at all seasons, June (Goubaux), November (Railliet) and December (Kliem). It has been found exceptionally in the eye and peritoneum of man.

Symptoms. These may be entirely lacking. In other cases there was slight conjunctivitis (Goubaux, Railliet) and in still others active inflammation. In Railliet's case there were tumefied painful lids; red, infiltrated conjunctiva; a constant discharge from the inner canthus, and two erosions of the centre of the cornea. In Kliem's case the lids were firmly closed, the flow of tears abundant, the cornea was vascular in its outer portion with a surrounding area of opacity, which was followed by a bluish white opacity of the whole cornea excepting at the inner canthus. Under treatment there was a general improvement but a month later there was a new attack and five filaria were discovered under the eyelids. The cornea became opaque and permanent blindness ensued. Goubaux noted a dilation of the lachrymal canals. The diagnostic symptom is the discovery of the worms, which is favored by the eversion of the lids and the squirming movements of the worms. When dried by holding the lids open for some time they become sluggish or quite still, but are at once roused into activity by moistening through renewed closure of the lids. They may easily conceal themselves in the folds of the conjunctiva or in the lachrymal ducts. The evolution of the worm is unknown. Railliet deposited an ovigerous female on the healthy eye of a horse, but no young worms developed.

Treatment consists in picking out the worms with the fingers, or still better with forceps, or in washing them out with a strong current of water injected under the eyelids with a syringe. The medicinal agents advised are non-irritant vermifuges, such as infusion of wormwood or quassia, tincture of aloes diluted in an equal

amount of water, pyoktanin solution (1:1000), and camphorated spirits in water. As showing the uncertainty of mercurials, five worms were found alive and active on the conjunctiva after repeated injections of a solution of mercuric chloride in tincture of opium. If, however, the worms were at that time in the lachrymal canals or ducts this apparent anomaly might be explained.

Filaria Lachrymalis Bovis. The filaria of the conjunctiva and lachrymal ducts of *cattle* was first noticed by Rhodes, later in 1838 by Coulom and still later by Ancéze, Lafosse, Baillet, Gurlt, Randanne. Like the filaria palpebralis of the horse it has been found at all seasons, but especially in summer and autumn, July, August, September, and November.

The Filaria lachrymalis resembles that of the horse but differs in its greater length (10 to 14 mm. for the male and 20 to 24 mm. for the female), in the transverse striation of the integument, by its two very inequal spicula, one six times the length of the other, and by its larger embryos.

Symptoms. Apart from the presence of the worms these may be entirely absent. In other cases acute conjunctivitis or keratitis may be present. The eyelids are swollen and tender, closed or semi-closed, with an abundant flow of tears. The conjunctiva is red and infiltrated. The cornea shows more or less opacity, vascularity, and even ulceration or perforation. The lachrymal canals may be distended. Finally the writhing worm is seen on the eye, and usually toward the inner canthus.

Treatment. This consists in the extraction of the parasites with finger or forceps, or washing them out by a current of water, and the application of non-irritant vermifuges. It is important to search for them under the lids, and the membrana nictitans. Serres has seen over a score of worms in one eye and Guittard as many as one hundred, and in such cases it is difficult to find and extract them all. By following the example of Randanne, in detaching the eyelids with retractors and injecting the conjunctival sac, all those that are not ensconced in the lachrymal ducts will usually be reached. The vermifuges usually employed have been dilute tincture of camphor, dilute tincture of aloes, and infusion of wormwood, to which may be added infusion of quassia or pyoktanin solution. These agents may be injected daily for several days, so as to destroy any hidden parasites when they emerge from the canals.

Astringent collyria may be necessary to correct any vascular irritation, and a weak solution of silver nitrate (0.5:100 may be applied daily to any existing ulcers or opacities.

PARASITES OF THE KIDNEYS AND VICINITY.

MICROBES. The microscopic germs, vegetable and animal (*bacteria and protozoa*), find an exit from the system mainly through the kidneys and hence these organs are liable to become the seat of a wide range of infectious diseases.

SPOROZOA. **Coccidia**. These like bacteria tend to the kidneys, and are liable to arrest and multiplication in the renal substance, urinary passages and bladder.

Eimeria falciformis has been repeatedly found in the equine kidney, aggregated in white spherical nodules and so abundant as to dangerously and even fatally interfere with the normal secretory functions (Pachinger).

A *monosporean coccidium* producing four, instead of two, falciform bodies in each sporoblast, was found in the dog's kidney. (Pachinger).

Coccidum truncatum was found in the kidneys of the goose in given localities, causing a plague, the substance of the organs being thickly studded with the white coccidian nodules, varying in size from a pin's head upward. Microscopic examination shows that they are mainly lodged in the uriniferous tubes, the sporoblasts at first invading the epithelial cells, but found also free in the unencysted condition. They are rounded and smaller than the *C. oviforme* of the rabbit's liver, 20 to 22μ by 13 to 16μ. The sporoblast shows a very evident micropyle at its narrowest pole. Many have a mass of granular contents, while in others the granules are concentrated into a spherical ball. At different points the invaded epithelium has desquamated, its place having been taken by the clusters of the sporoblasts.

The symptoms shown by the affected geese are complete loss of appetite, unsteady gait, weakness of the limbs, the animal lying on its breast or back, and when raised making a few staggering steps, only to drop into the same position as before. The free coccidia are passed in the urine and may be detected by a

careful microscopic examination. The *treatment* should be mainly preventive and on the same lines as for other coccidia.

CESTODES. The larval or cystic form of different tape-worms, *Cysticercus tenuicollis*, *cellulosa*, *Echinococcus*, etc., are liable to connect themselves with the kidney, the latter especially developing in its substance where it causes serious functional derangement, and in the case of detached scolices blocking the passages, and causing uræmia, dropsies, nervous and other disorders.

Wolpert even claims to have found a *Tænia serrata* (strobila) wound round the left kidney of a dog, a state which is not likely to be repeated.

TREMATODES. The *Bilharzia crassa* of the ox and sheep, already described, causes congestion, exudation, swelling and ecchymosis of the vesical mucosa. This determines clouding of the urine as does the *Bilharzia hæmatobia* of man, and it has been even suspected as a factor of the African hæmaturias of ruminants.

It must be met by drainage, salt and other anthelmintics as are the trematodes in general, only that, having sexes in different individuals it cannot be successfully dealt with by cutting off an intermediate host outside of the body as can the distomata.

NEMATODES.

STEPHANURUS DENTATUS. SCLEROSTOMA PINGUICOLA. LARD WORM OF PIG. KIDNEY WORM.

The term *Stephanurus* (stephanos crown, oura tail) was derived from the broad 5-lobed clasping membrane of the tail of the male, which has been supposed to represent a head-dress; and *Dentatus* (toothed) from the six firm tooth-like papillæ which surround the buccal orifice. The term *Sclerostoma Pinguicola* was adopted by Verrill from the papillæ of the mouth and the habitat of the worm in a cyst in the sublumbar fat (pinguis fat). Louise Taylor of the Bureau of Animal Industry takes strong grounds for abandoning the first name in favor of that of Verrill and remanding the worm to the genus *Sclerostoma*.

Description. The *female* worm averages 37 mm. in length; the *male* 32 mm. The body is plump, the mouth terminal and by

reason of the papillæ it has, when open, a hexagonal outline and is funnel-shaped, and turned slightly ventrad. The median ventral and dorsal papillæ are more prominent than the others. The mouth has also a circular fringe of 35 to 40 fine cilia. The anus is terminal in the *male*, and it further serves as an opening for the genital tract and the protrusion of the two spicula. The anus in the *female* is .64 mm. in front of the caudal extremity, and the vulva, .99 mm. in front of the anus. She has two small cuticular bladder-like swellings in front of the tail. The digestive canal is seen through the transparent skin as a dark convoluted tube extending the whole length of the body and contrasting strongly with the white cephalic glands and generative organs. The *ova* are .1 mm. by .056 mm. and undergo segmentation in the uterus.

Development. The eggs, fresh from a newly killed pig, were hatched out in water in Petri dishes, kept at a temperature of 74° F. On the fourth day the free rhabditiform embryos had escaped. In two days more these moulted and assumed the form of the young worm. No intermediate host has been demonstrated for the larvæ, and in spite of the assumptions of such a host by different helminthologists, L. Taylor concludes from the habits of allied species that probably no such host is required, but that the young worm after moulting can be taken in and matured in the pig.

Habitat. First found in 1834 by Natterer in cysts in the mesentery of Chinese hogs in Brazil. It has since been found abundantly in North American and Australian swine. It most commonly occupies cysts in the fat in the vicinity of the kidneys, or even in the mesentery, but not unfrequently it invades different solid organs of the abdomen as the substance or pelvis of the kidney, the ureter, the liver and spleen. Fletcher even claimed to have found it in the lungs, but it has been supposed that he mistook the Strongylus Paradoxus for the worm under review. Dean claims to have found the ova in the urine which, together with their presence in the liver, may explain the escape of the eggs with both urine and fæces, and the hatching and moulting of the young worm externally.

Cysts. The cysts vary in size and are often collected in groups, each cyst usually containing two worms, a male and female ; less

frequently a male and two females, or a female and two males, and still more rarely, four or five worms in a single cyst. Beside the worms the cyst contains a quantity of purulent debris, including multitudes of ova. In old cysts the parent worms may have died and disintegrated, leaving only the ova. Lutz has observed peritoneal effusions and fistulous indurations in connection with the encysted worms in the vicinity of the kidneys.

Fletcher found that when the worms were very numerous in the liver and when general disorders had set in, there were extensive hepatic congestion and softening. To the ravages of the worm he attributed a destructive epizoötic which went by the name of hog cholera. In these cases it is difficult to estimate, from the description, the relative causative importance of the encysted hepatic parasites on the one hand, and of a possible coincident hog cholera infection on the other. Hepatic derangement might well cause portal congestion, intestinal catarrh, indigestions, fermentations, and dysenteric disorder, to say nothing of metabolic or microbian toxic products in the liver. The case may be fairly compared to outbreaks of alleged hog cholera, which were found to be associated with multitudes of intestinal worms, and in which the free administration of tobacco led to a cure. With our present light it is important to bear in mind that the stephanurus may enter and encyst itself in the liver, in large numbers, producing symptoms that resemble those of acute congestive affections of that organ. Also that secondary gastro-intestinal disorders, easily mistaken for hog cholera, may result. On the other hand we should bear in mind that Fletcher found the parasite in nine out of ten pigs killed in the Indianapolis abattoirs, although the animals had shown no sign of illness, being in fine condition, and killed for packing.

Pig breeders in America have been in the habit of attributing all cases of weakness, stiffness, and paralysis of the hind limbs in swine, to this kidney worm, but there can be no doubt that this wide generalization is usually erroneous. Rheumatism, sprained back, rickets, intestinal disorders, causing sympathetic nervous atony, disordered innervation as the result of poisoning of the nerve centres by toxins produced by fermentations in the swill or fodder, or in the intestinal contents, or by microbian invasions elsewhere, congestions of the spinal cord or kidneys, renal

calculus, poisoning by ergot or smut, by the seeds of vetches, rye grass, millet, or cotton, or by any one of the many narcotics, may in turn produce a paresis, or paraplegia which by the swine-breeder would be unhesitatingly attributed to the kidney worm. Yet on the other hand the presence of multiple stephanurus cysts under the loins, or still more so in the kidney or ureter, or as Verrill suggests, in the spinal cord, might well bring about the weakness of the hind limbs.

If, however, along with the paretic symptoms, we can at the same time find the elliptical ova of this worm, or of the Eustrongylus Gigas in the urine, there need be no hesitation in incriminating the parasites as prominent factors in the causation.

Symptoms of Stephanurus are very problematical apart from indications of hepatic, spinal or renal disease including of course ascites. Yet if *post-mortem* examinations, have demonstrated the existence of the parasite in the locality, or herd, and if the ova are found in the urine or fæces, the hepatic, renal or spinal disorder, and the ascites, occurring in a number of pigs in the same herd, simultaneously or in succession, may be plausibly, or sometimes confidently attributed to the kidney worm.

Treatment. This is extremely unsatisfactory, mainly because the worms are encysted in the solid tissues, in the midst of a purulent debris, so that any vermicide introduced by the mouth could not be hoped to reach them in a sufficiently concentrated form, and because that even from its diluted solution in the blood the exosmosis into the worm-cyst is too limited to be in any degree of value.

Swine breeders usually resort to arsenic in large doses (10 or 20 grains or more), the general apparent harmlessness of which argues that it has been promptly rejected by vomiting. When recovery follows, it seems to indicate that the disorder has been hepatic or gastro-intestinal, and that the stimulus to stomach, bowels and liver, and the attendant elimination have given relief. If given at all as a vermicide for the encysted worms, the arsenic would be most rationally given in small physiological doses, continued for a length of time, but even then the hope of a good result can hardly fail to be disappointed.

Prevention. Every effort must be made to break the chains of succession in the reproduction of the lard worm. The presump-

tion is that the worm passes no part of its cycle of life in any other animal than the pig. There is no evidence of any other genus of vertebrate or of invertebrate animals proving a host of the parasite in its immature or mature condition. There is therefore no need of any restriction with regard to other domesticated or wild animals.

Hogs should be excluded from all ground known to be infested, or on which infested hogs have been, or which receives drainage from fields, lots or pens occupied by other hogs; also from water derived from wells having leakage through a porous surface soil, and from ponds, lakes or streams that are likely to bear the ova of the pinguicola. If the parasite exists in the vicinity, the restriction of the water supply to deep wells, raised and closed at the mouth, and cemented sufficiently far down to prevent all surface drainage, or the boiling of all water supplied will be a most important precaution. Above all, the pigs should be kept apart from slaughter-houses, and streams into which they drain, and on no account should they be allowed the offal or flesh of other pigs, including scraps from the kitchen, until such material has been thoroughly cooked. The common feeding trough of the pig invites infestment, since the animal can get in not only with his nose but also with his feet, filthy from direct contact with the urine and fæces of himself and others. The trough should always have a sloping cover, extending forward and upward at an angle of 45° from the posterior border, and which will at least exclude the feet from the food. The trough should further be cleansed daily and disinfected by a solution of salt, sulphuric acid or copperas.

As in the case of other communicable diseases of pigs, the massing of these animals in large herds in the contaminated localities is particularly dangerous, and their separation into small lots in distinct enclosures, or better still, the seclusion of each pig in its own pen will do much to prevent the propagation of the parasite. If kept on paved or cemented floors only, and scrupulously clean, infestment will be largely obviated.

Finally, purchased pigs should only be added to sound herds on the basis of irrefragible evidence of the soundness of the herds and locality from which they came, and even then only after quarantine.

STRONGYLUS GIGAS. EUSTRONGYLUS VISCERALIS. GIANT STRONGLE.

This largest of the round worms makes its internal habitat mainly in the urinary organs or immediately adjacent parts, but has been found in other internal organs as well.

Distribution. It is widely distributed in the Old World and the New, and probably no country can be held to be entirely free from it. It is most common near the sea coasts, rivers and lakes.

Hosts. This parasite preys on a wide range of victims including man, horse, ox, dog, wolf, mink, marten, otter, seal.

Characters. This worm is white or red, of nearly uniform thickness but tapering toward the extremities, finely striated transversely, and with several raised, longitudinal bands ; mouth terminal, triangular, with 6 papillæ. *Male* 13 to 40 cm. long : 4 to 6 mm. thick, with blunt tail having a terminal, saucer-shaped, ribless membrane, and single spiculum. *Female* 7 to 39 inches long : 5 to 12 mm. thick, with obtuse, curved tail, and vulva near the mouth. Oviparous. Ova brownish, 68 to 80μ long by 40 to 43μ broad.

Development. Segmentation takes place in the egg before it is laid, but hatching out of the embryo only occurs after laying when the egg is in contact with water or damp earth. The unhatched egg may be a whole year in the cold without losing its vitality, but is easily destroyed by drying. When hatched the embryo is easily killed by drying, and may early perish in pure water though living well in albuminous fluids. It is cylindrical, thick in front and tapering behind, having a conical head and terminal mouth furnished with a protractile, chitinous dart, evidently intended to perforate its intermediate host. What that host is is still unknown, though the presence of the parasite as a mature worm in fish-eating animals suggests a fish or aquatic animal as the probable bearer. Schneider has even found an Eustrongylus larva (Filaria Cystica) encysted in fishes. Balbiani, however, failed to hatch the ova of Strongylus Gigas in the alimentary canal of various fishes, in snakes, tritons, river prawns or dogs. It is probable that the larva of S. gigas may be found among F. cystica in fishes.

Strongylus Gigas in the Dog. A variety of different organs may be infested but the urinary organs and especially the pelvis

of the kidney are the most common seats of the worm. In a number of cases in which the parasite was found elsewhere there was reason to believe that it had started its career in the kidney and migrated from this point. In a list of 41 specimens, 16 were found in the kidneys, 10 in the peritoneum, 6 in or on the liver, 4 in the connective tissue between the thighs, 2 in the vicinity of the urethra and scrotum, and 1 each in the ureter, bladder and pleura. It is much more frequent in dogs than in other domestic animals, and especially in such as feed on raw meat (fish)—setters, pointers, retrievers, spaniels and mongrels.

Symptoms. These vary according to the seat of the strongle, being often the result of nervous suffering and disorder referable to the pain, and in others, of the retention of the secretions of such organs as the liver and kidneys, and again from toxic matters due to alteration of the metabolism effected in such organs. When the worm is so situated as to cause neither mechanical nor toxic trouble, symptoms may be entirely overlooked, and the discovery of its presence is only made on *post-mortem* examination.

From the local action on the kidney there is liable to be stiffness or tenderness of the loins, walking with the body turned to the affected side, paresis of the hind limbs, the suppression of urine, or its passage drop by drop, the passage of blood by the urethra, and the presence of the ova in this discharge.

Vomiting is not uncommon, extreme restlessness, moaning, yelping or howling and some form of nervous disorder. This may take the form of drowsiness, champing of the jaws, grinding of the teeth, convulsions, or simply taciturnity and a disposition to snap or bite. Hence cases of this kind have been mistaken for rabies, the patient refusing food, seeking seclusion and biting anyone who approached him. Yet Silvestrini found in such cases symptoms of intense suffering rather than of rabies, the face was pinched rather than sinister or ferocious, the eye was not prominent but retracted, the pupils contracted in place of dilated and flashing, and the membrana was protruded over a portion of the bulb. Though impatient of interference there was no mischievous disposition to attack.

With the worm in the *ureter* the same class of symptoms is liable to appear, for though urine may still pass from the kidney on the sound side, yet the obstructed ureter leads to accumula-

tion in the pelvis, compression, degeneration and absorption of the renal parenchyma, the resorption of urine and toxic products, and general poisoning especially of the nervous system. In such cases, as in the obstruction of the ureter by calculus, the renal tissue is progressively absorbed, beginning with the softer cortical structures and ending with the more resistant blood vessels, the albugenic tunic is greatly thickened and finally there is left only a thick fibrous sac enclosing a liquid which still retains an urinous odor.

With the worm in the *bladder* there is the same general class of symptoms, with the frequent passage of more or less flocculent or bloody urine and ova. As in the case of obstruction in the urethra both kidneys may suffer, with the supervention of acute uræmia, nervous disorder, and early death. The presence of the worm may be detected by the finger in the rectum, or ova may be found in the urine.

In the *urethra* the worm is liable to be arrested by the bone of the penis, yet in some instances it has been passed accompanied by blood, and with much effort and suffering, followed by permanent relief. When arrested in the urethra it sometimes bores through its walls and curls itself up in the cellular tissue between the thighs, usually near the scrotum, rapidly developing a swelling as large as a walnut or the fist, in which the convolutions of the worm can be detected. Even when retained in the urethra its presence may be detected by the distension and firm cord-like swelling, together with the complete suppression of urine in spite of violent straining. The obstruction may be further shown when it is attempted to pass a catheter, and ova may be detected in any liquid obtained.

With the *strongle* in the *peritoneum* the evidence of peritonitis is more or less manifest. Inappetence, vomiting, arching of the back, stiffness of the hind limbs, tenderness and fluctuating swelling of the abdomen are significant, but fail to give actual diagnostic symptoms. If, however, there has been clear evidence of prior renal disorder, with the passage of ova or blood, it may be possible to reach a better conclusion.

In case of invasion of the *liver*, the only data to guide one would be the evidence of previous or concurrent renal disease on which the hepatic trouble had supervened.

In invasion of the *pleura* Magnié found vomiting and asphyxia with sudden death.

Megnin records the formation of a mammary tumor in the bitch, which being opened, gave exit to a strongylus gigas, and prompt recovery followed.

As the primary invasion is believed to be in the kidney in all, or the great majority of cases, the prior existence of renal disorder should always be ground for suspicion of *Strongylus Gigas* in a susceptible animal in an infested region.

Strongylus Gigas in the Horse. In the horse the symptoms should be similar, but the disease being much less common they have been less clearly identified, most specimens having been found only *post-mortem*. Labat alone records disorder of the urinary organs in an affected mare, and examination of the urine during life would doubtless have revealed the presence of the ova in that liquid. Yet in Chabert's case the mare's left kidney seems to have been to a great extent absorbed, being represented by a very capacious sac of purulent fluid in which the worm floated. Careful observation during life could not have failed to detect renal symptoms and the urine must have furnished abundance of ova.

Strongylus Gigas in the Ox. There has been a similar lack of careful observation of the symptoms in cattle. Greve, however, records the case of a bull which for a year showed difficult urination and dribbling of opaque flocculent urine, and in which the left kidney was represented by an enormous sac filled with a foul purulent fluid and containing a *Strongylus Gigas*.

Treatment. The main difficulty, as in the case of all worms outside of the alimentary canal, is in bringing in contact with the parasite, a vermicide strong enough to destroy it, and yet harmless to the system of the host. Neumann suggests oil of turpentine to cause the worm to emigrate, but this agent is transformed before it is eliminated through the kidneys. Arsenic which is mainly thrown off by the kidneys is more promising, given in small doses for a length of time. Quinia and strychnine are both secreted in large part by the kidneys unchanged and might be profitably combined with the arsenic. Quassia and other bitters might also be tried. Naphthalin, pyoktanin and other vermicides may be tried. The verminous tumors may be laid open and the worm extracted.

OTHER WORMS OF THE KIDNEY.

Sclerostoma equinum, in its larval stage, occasionally wanders into the renal arteries, or is washed in by the great force of the blood current, and there forms verminous aneurisms. They may even reach and block the renal arterioles causing passive congestion, inflammation, uræmia and paralysis. They at times break through into the pelvis of the kidney, and may thus reach the ureter, bladder or urethra. Finally they have been found in large numbers in the connective tissue around the kidney. Stiffness, and weakness of the loins, paraplegia, and nervous disorders of various kinds may follow. The elimination of sclerostomata from the animal system, and locality, is the rational treatment. (See S. equinum).

Trichosoma plicata. This inhabits the urinary bladder of fox, wolf and dog. *Male* 13 to 30 mm. long, with pointed tail and long transversely grooved spiculum. *Female* 30 to 60 mm. long, with blunt tail, terminal anus and vulva in anterior part of the body.

T. Felis found in bladder of cat, wild and tame, the *female* only having been seen. Length 14 to 16 mm., usually coiled in spiral and tapering very slightly toward the tail.

Small **larval round worms** are found in the cortical substance and under the capsule of the kidney of the dog, in pearly-white spherical or flattened tumors the size of a hempseed. The cyst is made up of layers of connective tissue compressed by the adjacent glomeruli and uriniferous tubes. The size of the worm varies with its age, from 140μ (Rochefontaine), to 363μ (Ebstein and Nicolaier). Nephritic symptoms might be expected when they are numerous and recently domiciled.

Holzendorf claims to have found **Cytodites nudus** in the kidneys of chickens.

Pagliero, found two larvæ of **Æstrus hæmorrhoidalis** in a Norman stallion, attached to the mucosa of the bladder, near the cervix. It is assumed that these parasites, passed in the manure, had entered the distal end of the urethra and traversed its entire length. The horse had died of colic.

OTHER PREDACEOUS, VENOMOUS, AND ELECTRIC ENEMIES.

Tarantula: Hairy spiders of S. Europe, Asia, Africa, tropical and subtropical America; poisonous but rarely dangerous. Mental disorders, hysterical. *Bird-Spider* of S. America; *Scorpion Spider* of Costa Rica; *Latrodectus Lugubris* of Kirghiz, irritating and even deadly; *Kalipto* of N. Zealand, causes great prostration. *Treatment:* lead lotions, alkaline, phenated, permanganate, creolin, chloral; ammonia, digitalis, strophanthus, nitroglycerine, coffee in heart failure. *Centipedes:* Poison, rarely dangerous; in tropics more so; cyanosis, nausea, prostration, paresis.

SPIDERS. TARANTULAS.

The large, hairy spiders of Southern Europe, Asia, Africa and America are known as tarantulas, and have long been charged with causing dangerous and even fatal wounds. They form nests in the ground, and are furnished with two formidable mandible claws which work vertically instead of laterally, as in other spiders. The best known species of our Southern States is the **Euryperma Heintzii.** The bite causes wheals with intense pain and itching, but no nervous symptoms, if uncomplicated by other poisons. The dancing manias of the middle ages attributed to this spider were mere manifestations of hysteria and have no counterpart in the lower animals, nor in man in modern times.

The bite of the **bird spider** of S. America (**Mygale auricularia**), which has a body two and a half inches long, is claimed to be fatal to birds, and to produce in mammals local inflammation, suppuration and induration (Schmarda). The **scorpion spider** of Costa Rica produces a spreading erysipelatoid dermatitis (Frantzius). The **latrodectus lugubris** of the Kirghiz Steppes, a spider of one-half inch long, is said to kill 25 per cent. of the large domestic animals bitten (in man 4 per cent.) Beside local pain and swelling, it causes cold sweats, restlessness, vertigo, nausea, prostration, cyanosis and convulsions (Ucke). The **Kalipto** spider of N. Zealand causes, for a few days, great pain, redness, great prostration, cold extremities, and feeble pulse (Wright). It is probable that, in most or all of the severe cases, another and more potent poison is introduced into the bite, in addition to the natural venom of the spider.

Ordinary spider bites may be **treated** with lead lotions, alkaline and carbolic lotions, solutions of potassium permanganate,

creolin, chloral or other antiseptic, or caustic. Ammonia locally and internally, and, in case of heart failure, digitalis, strophanthus and nitro-glycerine may be resorted to.

CENTIPEDES.

These, which abound everywhere and attain to large size in the Gulf States, are also charged with making dangerous wounds. They have poison-glands opening through the claws of the first pair of legs, but even in the south it is rare to find them wounding man or other mammal, and much more rare to see more than the most circumscribed and transient inflammation resulting. In the tropics the wound may kill with cyanosis, weakness, nausea, involuntary defecation, and lingual paralysis or paresis.

ANTS. FORMICIDÆ.

In tropics, Congo, Nicaragua, etc., neuters have caudal sting and venom gland, formic acid; deadly when attack in swarms. *White ant*, *Velvet ant*, *Cow-killer* of Texas. Ants as bearers of septic or other poisons. *Treatment*, as for bee stings. *Prevention:* Boiling water, burning petroleum, shavings, hay, etc.

The different families of ants deserve notice as venomous insects, which in warm latitudes appear at times to be actually dangerous to life. This applies especially to the tropics, and to the neuters and soldier ants. These working members of the colony, have in addition to their enormously powerful mandibles, a caudal sting fortified by a poison in which formic acid appears to be the main constituent. In northern climates stinging ants are exceptional but towards the equator the development of sting and poison encreases. Prevost speaking of the ants of the Congo region, describes how great armies will attack the natives and missionaries, and will even kill cattle in their stalls. Stanley is no less definite. Describing the invading ants he says: "Woe betide the unlucky naked foot treading upon a myriad. Better a flogging with nettles or cayenne over an excoriated body * * than these biting and venomous thousands climbing up the limbs and body, burying themselves in the hair of the head, and plunging their shining, horny mandibles into the flesh, creating painful pustules with every bite. Every living thing seems disturbed at

their coming. Men are screaming, bellowing with pain, dancing and writhing. * * The rats and mice, snakes, beetles and crickets are moving." Bates and Belt describe similar onslaughts, by Eciton predator, and hamata in Nicaragua and Central America. Birds and opossums flee in terror and frequently fall victims to the determined onslaught. The devotion of ants to a flesh diet and the rapidity with which they will clean the skeleton from a carcase placed by their hills, even in northern latitudes, is a fair index to the predatory habits of the more powerful and poisonous tropical ants.

The *termites* (white ant) which are not true ants at all, but neuropterous insects resembling ants, are equally predatory.

The **Velvet Ant** (Spherophthalma occidentalis) of Texas has been called the *cow-killer ant* because of its sting, and has been supposed to be very dangerous to live stock.

In the case of all these venomous wounds by small animals much depends on the latitude and season, the venom being more abundant and probably more potent in the tropics and in the hot season; on the size and vigor of the venomous assailant; on the numbers of the animals infecting; and on the question of whether it is the first bite or sting with much venom, or rapidly succeeding ones with less and less poison. A single sting is often comparatively harmless, when the stings of a whole hive or army would prove fatal. Another important consideration is the question of the presence, on the perforating organ, of extraneous poisons like those of decomposing flesh, or those of specific disease poisons like anthrax, nagana, or surra. Animals that prey on dead carcases and carrion are especially liable to carry poison in this way.

The *treatment* of ant-stings is essentially the same as for stings of bees, hornets and wasps.

In the way of *prevention* they may be destroyed in their hills or nests or even when on the march by boiling water, burning petroleum, by burning shavings, dry grass, etc., or by using some active insecticide (see Acariasis).

BEES, WASPS AND HORNETS.

Females and neuters sting. Venom, trauma, barbed sting; acquired immunity. Stings of swarm may kill. Excitement, panting, heart failure, debility, prostration. ***Treatment:*** **Soda or ammonia bicarbonate, potassium permanganate, phenic acid, cold, ice, lead acetate, chloral. Extract stings. Support flagging heart.**

Among these insects only the female and neuters are provided with stings, and they use them in self defence, when they or their nests are interfered with. The irritation depends in the first place upon the wound, but much more on the amount of venom left in it, and in many cases on the presence of the sting, which being barbed has been broken off and retained in the tissues. As a rule if the insect is left undisturbed it withdraws the entire sting, leaving a less irritating wound, but, if it is brushed off, the sting is often broken and remains. The part stung swells up more or less, presenting a white centre and a red œdematous periphery, with much itching. Vesication may take place and exceptionally a small portion sloughs. Much depends on the individual stung, bee-keepers after a number of stings usually acquire an immunity from the poison and are only affected by the slight wound, and some animals and men have an innate immunity. Simple stings are rarely hurtful to animals, but when horse or cow encroaches on a large colony, and is stung by a dense mass, the results may be rapidly fatal. The animal is violently excited, breathing hurried and panting, pulse rapid, weak and irregular, the parts attacked are swollen, and there is great debility and prostration.

In *treating* these cases an antidote to the formic acid may be sought in solutions of bicarbonate of soda or ammonia, or in permanganate of potash or even dilute carbolic acid. Cold applications are soothing and beneficial, cold water, ice, solution of lead acetate or chloral. The stings present in the wounds should be sought and extracted with fine forceps. Finally the heart may be supported by the injection of digitalin, strophanthus or nitro-glycerine.

SNAKE BITES.

Grooved teeth and venom glands in upper jaw; inflict two punctures; in some species four, may tear. Warm, sunny, dry places and by water. Vipers of Europe least hurtful; American snakes more so; S. American, Asiatic, African and Australian most. *Symptoms:* Two small punctures (sometimes four), great pain, swelling, violet color, oozing of black incoagulable blood, extensive sloughing if death is deferred; great prostration, weakness, difficult breathing, thirst, nausea, retching, unconsciousness, delirium, convulsions, weak, failing heart; action on respiratory and cardiac centres and blood Extravasations of liquid blood around bite, in serosæ and internal organs. Gravity affected by vigor of snake, quantity and potency of venom instilled, reduction of venom by recent bites, small size or weakness of the bitten, and degree of susceptibility. Immunity of swine and mongoose, subcutaneous fat little vascular; venom in blood-vessel very deadly. Poison acid, with alkalies inert; contains albumose. Not made inert by 154.4° F., which coagulates albumen. *Treatment:* Should be instant; collapse may occur in a few minutes. Tourniquet with broad band; cauterize with potash, lunar caustic or zinc chloride; suction through tube; wring or milk tissues; ammonia, potassium permanganate, tincture of chloride of iron. Internally, antitoxic serum of immune animal; stimulants, digitalis, strychnia, nitro-glycerine, ammonia, alcohol short of narcosis. Immunization by injecting venom in tip of tail; amputate if effects are excessive. Antagonism of snake venom to rabies, and abrine.

The dental armature of snakes consists of two rows on each side of the upper jaw, and in the venomous species one or more teeth on each side are enormously developed and furnished with a closed canal or groove, in different genera, which communicates with the poison gland back of the eye. In the quiescent condition the teeth are directed backward and flattened down, but when about to strike, the mouth is opened widely and the maxillary bones in which the poison teeth are embedded are moved by muscles so that the latter project at nearly right angles from the surface, ready to penetrate the victim. Meanwhile the poison glands are compressed by the temporal muscles so as to discharge the venom through the tooth into the wound. The wound will vary according to the snake, even with the strike direct, that of the rattlesnake, copperhead or moccasin usually showing two small, deep punctured wounds corresponding to the two poison fangs, while in other genera there may be four,—two in line on each side. The strike may however be oblique and the wound becomes a tear

or scratch in place of a series of punctures. The **rattlesnakes** (Crotalus durissus and horridus) and the **copperhead** (Cenchris contortrix) prefer warm, sunny, dry situations, while the **water moccasin** (Cenchris piscivorus) keeps by water and the adjacent banks and lives on aquatic animals.

The **vipers** of Europe are much less dangerous than these North American genera, but again the latter do not compare with the deadly character of many South American, Asiatic, African and Australian serpents. In India alone there are 20,000 deaths yearly in the human population from snake-bite, and the domestic animals suffer to a much greater extent.

Symptoms. Beside the character of the wound and history of the case, a snake-bite is manifested by great pain and swelling, with a white skin in the center, a violet discoloration for several inches around, and the oozing of a black incoagulable blood from the pricks. The inflammatory swelling may extend so as to involve a large area or an entire limb, and if the patient survives, extensive sloughing takes place. The constitutional symptoms may supervene in from a few minutes to two hours and consist in great prostration and weakness, hurried, difficult, perhaps gasping breathing, thirst, nausea, loss of consciousness, delirium or convulsions, with a gradual weakening of the heart, it may be to complete failure.

The action is evidently exerted largely on the respiratory and cardiac centres in the medulla, but also directly on the blood and especially the red globules, which fail to fulfill their normal respiratory functions. Extensive extravasations of incoagulable blood are found, not only in the wound and vicinity but also in the serous cavities and internal organs.

The gravity of the bite depends on a variety of causes, such as the size and vigor of the serpent, and the amount and potency of the venom instilled, the fact of the bite having been the first in a length of time or one of the last in a series which have expended the available venom and cleaned the teeth, the small size or weak or invalid condition of the animal bitten, and the question of a native or acquired immunity. A bite that would promptly kill a small animal like a chicken or rabbit, or seriously injure a dog or sheep, would have little more than a temporary local effect on an ox or horse. The pig, like the mongoose, is reputed to be quite

immune, and as he thrives on a diet of rattlesnakes, he is availed of to clear up infested localities. A part of the immunity of the pig depends doubtless on the thick layer of subcutaneous fat, which being comparatively little vascular, allows of slow absorption only, and the system meanwhile becomes inured to the action of the poison. The same happens to other animals when the bite takes place in a dense, fibrous tissue of little vascularity. A circumscribed inflammation and slough may be the only result. On the contrary, when the venom is discharged directly into a vein it acts promptly on the blood and the nerve centres and too often produces prompt collapse and death.

The poison of the snake has an acid reaction and mixed with a solution of potash before inoculation it is rendered inert. If, however, it is once inserted in the tissues the local use of potash and its exhibition by the mouth fail to prevent poisoning. Certain snake venoms contain 20 per cent. of solid matter including an albumose to which a part of the potency must probably be attributed. They retain their toxicity after prolonged exposure to 68° C. (154.4° F.)

The *treatment* of venomous snake bite must be both prompt and energetic. In the case of the more deadly snakes, death may take place in a few minutes from collapse or the profound depression of the nerve centres. The application of a tourniquet to retard the absorption of the venom is the first consideration. A broad band around the limb, tightly twisted by the aid of a stick, should be kept on even after the appearance of toxic symptoms, to reduce the amount of venom taken up, to a limit that the system may be able to deal with. A narrow, cord-like bandage is forbidden on account of the great tendency to local gangrene and sloughing. Cauterization is untrustworthy because of the smallness and depth of the wound which it is impossible to follow with certainty. And yet, if the direction of the fang can be reasonably determined that may be advantageously followed by the hot iron, a stick of caustic potash, silver nitrate or zinc chloride, or by one of the mineral acids. The latter may be introduced through a glass tube. In the absence of caustics, suction or wringing may be resorted to. The person sucking the wound must have no sores on lips nor gums and should wash out the mouth with a solution of potassium permanganate or carbolic acid (5:100) after

each successive application of the lips. A safer method is to apply a large tube to the surface around the wound and suck on the other end. Meanwhile the wounded tissues may be kneaded or wrung to favor the extraction of the blood, lymph and venom. A prompt and deep excision of the wounded tissue followed by suction is still more appropriate. Short of this, a free deep incision across the wound in different directions, followed by suction or wringing, may be resorted to. In any case local anti-venomous applications to the wound should be made. Ammonia has long been advocated, but though, like potash, antacid, it is quite as painful and less penetrating, and its results are not such as to indicate antidotal qualities. Less painful and, on the whole, more effective agents are potassium permanganate in a strong solution, or tincture of chloride of iron or of iodine, and these may be not only applied freely, but even injected deeply into the tissues with a hypodermic syringe.

The only known antidotal internal treatment is by the antitoxic serum of an immunized animal. Stimulants are useful only so far as they counteract the weakness of the heart, and prevent collapse, thereby allowing time for the exhaustion or elimination of the poison. For this purpose digitalis, strychnine and nitroglycerine are of material value. The judicious administration of dilute aqua ammonia, aromatic spirits of ammonia, whisky, brandy or camphor may be advantageously resorted to. Giving alcohol to intoxication serves only the one end of putting an end to the terror of the human patient. Apart from this, and habitually in the lower animals, such excessive doses prostrate the nervous system and rather conduce to a fatal result. Alcohol, like other stimulants, should be used to sustain by stimulation, and never in such excess as to lower vital functions and retard elimination.

The antitoxic serum from the blood of a rabbit or other animal that has been subjected to minimal, non-fatal doses of snake venom until it has become strongly immune, exerts a certain antagonism toward the venom. Three cc. mixed with 1 mm. venom for ten minutes, and the mixture then inoculated on a rabbit, prevented ill effects. The same mixture set aside for ten minutes and then heated to 68° C. (145° F.) proved deadly ; the activity of the serum appeared to be abolished, while that of the venom was unaffected. A more lasting protection may be gained

from the education of the leucocytes to produce their own antitoxin in animals likely to be exposed to snake bite For this purpose a minimal dose of venom may be inoculated in a non-vascular part, like the tip of the tail in cattle. If much swelling occurs, the results may be at once checked by amputation of the swollen part and the application of potassium permanganate. This immunization has been long recognized in localities where venomous snakes abound, the person or animal once bitten and surviving, bearing thereafter a sort of charmed life. It has even been alleged that the snake venom secures a measure of immunity against other poisons, as rabies (Fernandez), and abrine (Calmette). The precise meaning of such antagonism does not yet fully appear; it may be a physiological antagonism of two different alkaloidal or other poisons, as in morphia and atropia; or it may be a stimulation of the leucocytes of the inoculated animal to produce antitoxins that are in varying degrees protective against both poisons. When the immunity persists for a length of time the second explanation is the more acceptable.

GILA MONSTER. HELODERMA SUSPECTUM.

Only lizard with venomous teeth; very sluggish and little disposed to bite. *Treatment* as for snake bites.

This is one of the lizard family, about 12 to 16 inches in length, inhabiting the arid plains of Arizona in the neighborhood of the Gila river. It has been reputed to be the only lizard having venomous teeth, the tooth being channelled as in venomous snakes and connected with a gland at the fang. The local reputation of the animal is so bad that it has been named the *Arizona Devil*, and there is a fair amount of circumstantial evidence as to the deadly character of its bite. It is, however, very sluggish and apathetic so that it is difficult to rouse it to make an attack, and recent experimental observations have failed to develop any dangerous results from the secretion of the tooth-gland. It would appear as if the poisonous effects noted in other cases, were either due to extraneous toxic matters that had been accidentally lodged on the teeth, or as if the gland poison were secre-

ted at one time and not at another. In any case the animal is not given to biting, so that it is a source of little danger. When its bite is sustained, the precautions to be taken are exactly the same as in snake bite.

AMERICAN TOAD, BUFO LENTIGINOSUS.

When irritated has a poisonous secretion from skin glands that has been used to blister with. *Treat* by soothing ointment.

As a slightly poisonous amphibian the common toad may be noted. As in the case of the Gila monster, much of the vulgar dislike of the toad comes from its warty repulsive skin, and it is from the cutaneous glands that the poison is secreted. The secretion is an acrid fluid which becomes more abundant when the toad is excited, and some horsemen have tied a live toad on the skin covering a spavin or ringbone to secure a local blistering action. As occurring casually it is only in very exceptional circumstances that the skin of domestic animals would suffer in this way, and when this does occur a soothing ointment (zinc and vaseline) is all that is demanded.

LEECHES.

Family characters: Triradiate mouth with crests or jaws, making a triangular wound. Hermaphrodite. *Medicinal leech:* In ditches and ponds with pure water, vegetable growth and muddy bottom; common official form is the *Green leech*. *Trout leech:* In fresh running water in N. Africa. *Common American leech:* Bluish, 22 reddish spots on back; found in running fresh waters. *Horse leech:* Back greenish brown, belly reddish, lateral marginal orange bands; common in Europe, Syria, N. Africa, and N. America. Mature leeches in mud, young swimming; attack man and beast, fastening themselves to lips, nose, gums, tongue, soft palate, pharynx, posterior nares, larynx, trachea or stomach, drawing blood. *Aulastomum Gulo* and *Nephelis Vulgaris*, in ponds in England. *Land leeches: Hæmadipsia Ceylonica: Hirudo Tagala*, like knitting needle, live under leaves, in Java, Sumatra, Australia, Malay Peninsula, Burmah, China, Japan, Chile and Brazil; are most voracious in wet weather. *Blind leeches: Cyliobdella lumbricoides*, of Brazil, climb on vegetation in wet weather and attack animals. *Symptoms: On limbs*, as needle-like leeches gorge themselves they stand out in clusters on the bloody limbs. *In mouth, nose and pharynx*,

bleeding from nose, or on lips during work, leeches found on careful examination of mouth, etc. In *nasal fossæ* and *pharynx*, cause nasal bleeding, sneezing, snuffling, cough. In *larynx*, cause dyspnœa. On *conjunctiva* or *vagina*, local inflammation and bleeding. Often present in large numbers in small animals, causing emaciation and death. *Treatment:* Pinching the tail pick off; in mouth, seize through towel; clip in two; salt the leech; whalebone staff, with sponge charged with salt, benzine, chloroform, ether. Generous feeding; tonics. *Prevention:* Cultivation, drainage; thick bandages on legs; bag on mouth when drinking; stock infested waters with eels.

Leeches belong to the *annelid* family **Gnathobdellidæ**, from *gnathos* a jaw (greedy mouth) and *bdella* a leech or lamprey. They are usually spindle-shaped, but narrowing more toward the head than the tail, composed of 95 to 100 transverse rings, flattened on the ventral aspect and somewhat less so on the dorsal, and furnished with two suckers a caudal and a cephalic, the last having the oral opening. The oral sucker has three rings within each other and an orifice in three slits arranged one forward and two lateral so as to have a triradiate appearance. Each slit corresponds to a denticulated crest or jaw and the three perforate the skin so as to form a triangular wound. The leech bite can always be recognized by this triangular outline. Leeches are hermaphrodite yet the congress of two individuals is necessary to reproduction.

The different kinds of leeches that interest veterinarians are mainly the following:—

The **Medicinal Leech** (Hirudo Medicinalis) is dull olive or olive brown on the back, with six yellowish spots and lateral yellowish stripes, while the belly is grayish with black spots. The body is composed of 95 to 100 rings and the mouth is surrounded by four incomplete rings. These are found naturally in ditches and ponds, with pure running water, weeds for shelter and muddy bottom and banks. They bite man or beast that may wade in the water. They are more or less common in Europe, Western Asia and Africa. A number of varieties have been described, one of the most common of which is the **Green Leech** (H. Officinalis) distinguished by its greenish shade and the absence of spots on its venter.

The **Trout Leech** (H. Troctina, Interrupta) about the same size as the medicinal leech (80 to 100 mm. when extended) has a

generally greenish back, with bright round spots, and orange or reddish borders. This is an inhabitant of the fresh running waters of Algiers and Northern Africa generally, and has been used in medicine as a substitute for the medicinal leech.

The **Hirudo Decora**, the common leech of N. America is bluish in color, with about twenty-two reddish points on the dorsum, and a series of lateral black spots. Found in the running fresh waters this is smaller than the medicinal leech, drawing about a drachm of blood instead of 1¼ drachm. It fastens on animals and men that wade the streams.

The **Horse Leech**, Haemopis Sanguisuga or Vorax, of nearly the same size as the medicinal leech is soft, greenish brown on the back, and with ventral aspect reddish or olive. It is marked by minute black spots closely aggregated, and along its borders by an orange or brownish red band. It is reported to be common in Europe from Sweden to Portugal and Turkey, in Syria, Algiers, the Canary Isles, and North America. The mature leeches burrow in the mud, while the young disport themselves freely in the water. They attack man or any domestic animal that may come in their way, but they are especially troublesome, when taken with the drinking water, fastening themselves on the nostrils, lips, gums, tongue, palate, soft palate, pharynx, larynx or trachea. They may penetrate into the posterior nares, or even the stomach.

The **Aulastomum Gulo** or **Vorax**, and the **Nephelis Vulgaris**, which frequent British ponds and streams, are often confounded with the horse leech and are about equally dangerous and troublesome. The first of these is characterized by two large cæca extending backward from the stomach. The Nephelis is about 3 inches long when extended, with dorsum brownish yellow and tesselated, and belly olive.

In damp, tropical countries **land leeches** are common, living among damp leaves in thickets during the dry season, and assuming great voracity in the rainy season, when they fasten themselves on man or animal that may invade their habitat. Among these may be named **Hæmadipsia Ceylonica** (Ceylon), **Hirudo Tagala** (Philippines), small leeches no thicker than a knitting needle when fasting, but very voracious. Similar leeches infest other tropical and semi-tropical countries as Java, Sumatra,

Australia, Malay Peninsula, Burmah, China, Japan, Chile, and Brazil. In the Philippines they are found up to an elevation of 4,000 feet, and in the Himalayas of 10,000 feet. The Blind leeches **cyliobdella lumbricoides,** of damp earth in Brazil may be simply named in this connection. These land leeches, in the rainy season, climb upon vegetables, shrubs and trees, and seize upon their victims whenever available. It is, however, from the mud, leaves, grass and low vegetation that they are to be especially dreaded, as they will attach themselves in clusters to the bare feet, ankles and legs of persons and to the feet and limbs of animals, and, by the frequency and abundance of the resulting depletion, they cause anæmia, weakness and general debility.

Symptoms. These vary according to the part of the body attacked : In case of the *limbs*, the leeches, at first overlooked by reason of their small size, soon fill themselves with blood and stand out singly or in clusters, while the parts may be more or less bloodstained. Nervous horses are rendered violent and unmanageable.

The *mouth*, *nose* and *pharynx* are the most common points of attack. The small, fasting leeches, like blackened fragments of grass stems, are taken in with the green food or the water, and fasten themselves on the alæ nasi, the Schneiderian membrane, the lips outside or inside, the lower surface of the tongue, the frenum, the cheeks, palate, soft palate, pharynx or larynx. When they are on the buccal mucosa, the animal host may swallow the oozing blood so that it does not appear at the lips excepting during work, when the bloody saliva escapes beside the bit or from the lips generally. The irritation may lead to constant movements of lips, jaws, or tongue, and in extreme cases to refusal of food even. A careful examination of the opened mouth will reveal the presence of the leeches. Further irritation may come from local infection of the wounds or the introduction of barley beards and other spikes, causing profuse salivation.

In the *nasal fossæ or pharynx* the leeches cause a bloody discharge from the nose with sneezing, snuffling or cough, according to their situation.

When attached to the *larynx* or its upper margin, they cause violent spasmodic coughing and dyspnœa, and it may be prompt suffocation.

Bijard has found a leech attached to the *conjunctiva* of a horse, producing acute inflammation and suppuration mingled with blood so that the trouble was at first attributed to a blow.

Guyon has found them in the *vagina* in mare, mule and cow. Here irritation with bloody mucopurulent discharge directed attention to the annelids.

The numbers taken in are sometimes remarkable. Blaise found 185 of the average thickness of the little finger in the pharynx of the horse, and Reynaud 192 in the interior of the larynx.

The following experiments were made by Guyon on small animals. Young horse leeches were introduced into the nasal chambers and rectum of rabbits, and into the oviduct and œsophagus of chickens. Those in the gullet of the fowl were seen at intervals to advance the head into the larynx, throwing the bird into violent paroxysms of dyspnœa. All these animals became greatly emaciated, the birds died in 35 to 45 days, and the rabbits from the 45th to the 60th.

The time during which a leech may remain attached to its victim is uncertain. Cases are recorded in which they were found in the pharynx of the ox eight days after it had left the country whence the leech came (Megnin), and in that of man 12 days after leaving the infested land (Daulos). But we cannot be assured that the leech was not derived on the voyage, from the water or food shipped with the victim.

Treatment. From the skin, lips, mouth or eyes the leeches may be picked off with the fingers or with forceps; the firm pinching of the tail usually leading the parasite to let go. When in the mouth, where they are very slippery, it has been advised to cover the hand with a towel to give a better hold. Another resort is to clip them in two with scissors. Here, as upon the skin, salt may be used freely to make them let go. For those in the pharynx it is still possible in some cases to pick them off. This failing, fumigations of tar may be tried, or better, a whalebone staff with a small sponge on the end saturated with a strong salt solution, benzine, chloroform or ether, may be introduced through the nose or mouth. They may be removed from the nasal fossæ in the same way, or the nose may be injected by syringe, fountain syringe or Rey's tube.

Anæmia and debility must be treated on general principles.

Prevention is difficult. The leeches tend to disappear under drainage and cultivation. For those that live in water, filtration and screening are insufficient as a number of the very young and small usually get through. The protection of the individual animal has been sought by applying thick bandages to the legs, on infested lands and water, and by covering the nose and mouth with a nosebag of cloth when taken to watering (Abou Bekr). The most promising preventive measure is that of Lemichel who introduced eels into the watering places of the animals and thus successfully did away with the leeches. This is on the same principle that the mosquito is not bred in waters abounding in fish or frogs, which destroy the larvæ as they appear.

ELECTRIC EEL. GYMNOTUS ELECTRICUS.

Frequent marshes and fresh waters in Brazil and Tropical America. Benumbs domestic animals; 5 to 6 feet long. Structure of electric organs. Discharges exhausted by repetition, thus the eels can be killed. Bridging of streams; wearing tall rubber boots and clothes.

The electric eel of marshes and fresh waters in Brazil, Guiana and other tropical American countries, the most powerful of electric fishes, is especially liable to come in contact with domestic animals which it benumbs or kills by its discharges. It attains to a length of 5 or 6 feet and is distinguished by the entire absence of caudal and dorsal fins, and by the extraordinary development of the anal fin, which extends as a long fringe along the lower aspect of the body from throat to tail. Its electric apparatus consists of two pairs of natural batteries, extending from before backward, directly under the skin, one in the line of the anal fin, and the other in the back of the tail. These are divided up by fine septa, arranged vertically and transversely into a myriad of cells, each $\frac{1}{30}$ inch in diameter, and filled with a gelatinoid cellular structure. These batteries are most abundantly supplied with over 200 trunks from the anterior branches of the spinal nerves. In their course the electric nerves supply twigs also to the skin and muscles. The nerves furnished to the elec-

tric organs are much larger than those supplied to organs of motion, sensation or special sense.

The discharges are under the control of the fish, and by frequent repetition the power of the batteries is temporarily exhausted so that the eels can be caught by harpoons and destroyed. The power of the shock further bears a direct relation to the size and vigor of the eel, in this agreeing with the potency of the snake venom. In a well developed, vigorous gymnotus, a favorably directed shock is capable of killing the largest animal. In the fording of infested streams and marshes large numbers of horses are destroyed, and it has been found needful to change the course of highways to avoid the danger. Bridging of streams would be an obvious precaution, also the use of rubber boots or bandages by those that must enter the water.

The Indians, who eat the eels, take the precaution to drive horses into the infested pools or rivers, on which the fish may expend their electric power, and when in a condition of exhaustion the gymnoti approach the banks, they can safely harpoon them and pull them ashore.

ELECTRIC RAY. TORPEDO. MALAPTURUS. MEDUSA.

Electric rays have electric apparatus on each side, having septa with spaces containing gelatinoid matter and nucleated cells. Found in Atlantic and Indian Oceans; the largest in the tropics. *Jelly fish* shock man and animal. *Sheath fish* of Central Africa has batteries on the surface, strongest on abdomen. Same precaution as for electric eel.

The **electric rays** are fair counterparts of the electric eel. In these the electric batteries lie one on each side, and are formed of septa enclosing minute cells containing a gelatinoid matter and nucleated corpuscles. They are found on the coasts of the Atlantic and Indian Oceans, some of the smaller forms even as far north as Great Britain, while the larger specimens (sometimes 80 to 100 lbs.) are either tropical or semi-tropical. Their shocks benumb the unfortunate fishermen who may chance to hook them, being transmitted along the line, but as they prefer deep water it is only exceptionally that any of the lower animals suffer from their attacks. This can hardly be said of the **Medusa** or **Jelly**

Fish which floats in deep and shallow waters, and shocks man or animal that may come in contact with it. Fortunately its power is very slight, and the sensation produced is that of a smart slap or a sudden stinging pain.

The **Malapturus** or **Sheath Fish** of Central Africa, on the contrary, inhabits fresh waters, and shocks man and beast that may come in contact with it. In this animal the battery covers the body, but is thickest and strongest over the abdomen. It lies between the subcutaneous aponeurotic layers, and is constituted of rhomboid cells containing a gelatinoid material. The nerve supply is most abundant and is conveyed through an enormous spinal branch, distributed to the entire organ.

The same precautions are obviously demanded as in the case of the electric eel, the avoidance of fords through infested waters, the bridging of such waters when feasible and the defense of the limbs of waders by rubber boots or bandages.

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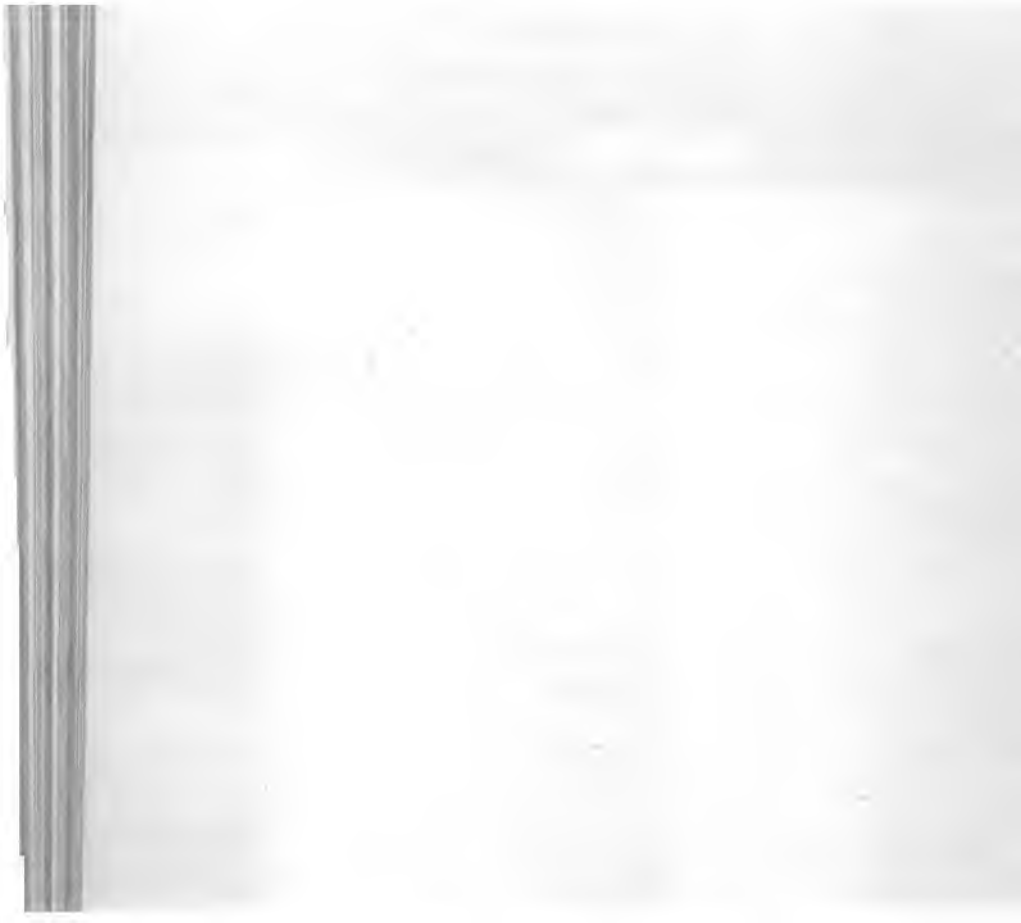

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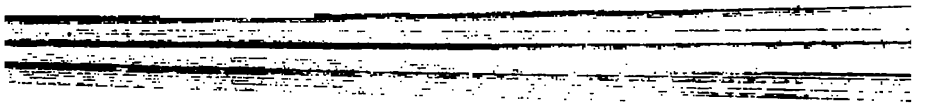

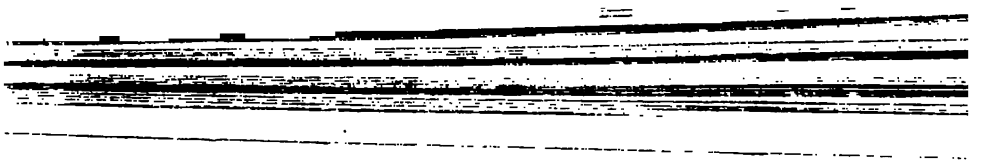

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